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EDITORIAL NOTES

LUMINESCENCE

IN May last was described the work on gas lighting research undertaken by Messrs. Minchin, Densham, and Wright in the Watson House Laboratories of the Gas Light & Coke Company. For the past forty odd years or so all gas lighting has had as its basis the light-giving powers of a mixture of thoria and ceria when heated in a gas flame. Approximately 99% of thoria mixed with 1% of ceria, with the addition of traces of a number of other substances for strengthening purposes, is the mixture employed for impregnating mantle fabric ; and it would seem that there is little prospect of finding a better mixture than the one already in general use. Gas lighting, as understood and practised, is a thermal effect. Developments recently made in gas burners are likely to result, through higher aeration and consequently higher flame temperature, in increased gas lighting efficiency, but on the purely thermal radiation theory of gas lighting there appears little prospect of ever increasing efficiency by more than, say, 100%—an amount which would still leave the energy efficiency exceedingly low. The present figure for a low-pressure lamp is about 0.2%. But must reliance be placed solely on thermal radiation ? In 1842 Balmain, who prepared boron nitride, discovered that it showed an " elegant green phosphorescence " in the outside fringe of a flame. With a specimen treated with boron nitride, the greenish-blue glow starts first as the specimen heats up. When it has become quite bright the red of normal incandescence begins to show itself, and only when the substance has reached a bright red heat is the green colour masked. This luminescence, it would seem then, is not a thermal effect, but a chemical phenomenon. Investigators have recorded as high a value as 40% for the chemi-luminescence resulting from the union of sodium and iodine under special conditions. " Once . . . the phenomenon of the incandescent mantle is established as being of the nature of luminescent the barriers are down, and there is no longer any theoretical reason why lighting efficiency should not be advanced ten or a hundred fold." We quote from a Paper by the foregoing investigators given to the Illuminating Engineering Society, an abstract of which was published in the " JOURNAL " of May 1, 1940.

The radiation from solid substances under flame impact is the subject of an investigation undertaken at Leeds University by Mr. E. C. W. Smith, the Arthur Duckham Research Fellow. The work is described in the Second Arthur Duckham Research Fellowship Report which has been published as a blue book (Communication No. 237) by The Institution of Gas Engineers. We intend to deal with the Report subsequently in the "JOURNAL." The work described had as its intention a rapid survey of the whole field of " candoluminescence " without any attempt at a detailed examination of particular aspects of the problem. It has served to establish beyond all doubt the reality of the luminescent phenomenon at low temperatures. The existence of a luminescent radiation from solids in contact with flame is of considerable significance, as offering what appears to be the only hope of a considerable increase in the efficiency of light production from the combustion of fuel gases. At the same time, it must be emphasized strongly that at present and with the data available to date, the practical application of these luminescent substances would appear to be beset with considerable difficulties. From its theoretical aspects the subject is of great interest owing to its bearing on the subject of luminescence in general, and very little attention has been given to it in the past, apparently on account of the unsatisfactory nature of much of the experimental evidence.

The survey of luminescent materials so far completed has provided information which will be valuable in the selection of further " activators " and parent substances. The establishment of a critical optimum concentration of any activator is of some importance. When other substances are examined it will be interesting to observe how this optimum concentration varies and on what factors it depends. The spectrographic examination, in addition to its theoretical implications, is of practical value in showing the distribution of the emission through the spectrum, and in demonstrating the possibility of securing almost any desired distribution—*e.g.*, one approximating to that of daylight—by the choice of a mixture of two or more luminescent materials. These conclusions are set out in the Report.

At the end of his Report Mr. Smith states that it is clear that further investigation will resolve itself into four main fields. First the examination of other substances, both as activators and as parent substances for the production of luminescent materials. As this work progresses, the periodic relation of the elements will, he suggests, serve as a useful guide in the selection of suitable materials. Secondly the consideration of the problem of using the activating flame with the greatest possible efficiency—*i.e.*, the design of a suitable burner and support for the luminescent material. Also, the determination of the overall luminous efficiency of the various sources, and the spectral distribution of their emission. Thirdly, the elucidation of the mechanism of the process responsible for the luminescence, and the relation with cathode-ray and ultra-violet luminescence. This will probably involve experiments on the effects of atoms and active radicals produced in the exit gases of electrical discharges and of radiation of very short wave-length. Fourthly, the investigation of the anomalous thermal behaviour in the high temperature range by means of infra-red spectrometry.

CARBONIZATION OF COAL OIL MIXTURES

AMONG other Papers at the annual convention of the American Gas Association was one given to the Technical Section by Messrs. Ramsburg and McGurl, of the Research Department of the Kuppers Company, Pittsburgh. The subject was the carbonization of coal-oil mixtures in coke ovens, and we reproduce the Paper in our issue last week. The whole subject of the addition of heavy oil change has been a research problem of the Company for many years, and the work described falls into two sections : The use of relatively large quantities of oil on the coal, 1.0 to 3.5% by weight for the purpose of increasing the yields of gas and other products, and for providing added flexibility in regard to products in a by-product coke oven plant ; and, secondly, the use of very small quantities of oil on the coal, 0.25 to 0.5% by weight, for the purpose of increasing the bulk density of the coal mixture, thereby maintaining or increasing plant capacity, and for controlling the moisture content, dust, and weathering of coals in transit or in storage.

Many advantages are said to accompany the procedure. Among those set out in the Paper, maintenance of a definite specific gravity in coke oven gas with removal of light oil is claimed, the B.Th.U. from bunker oil being used to replace the B.Th.U. in the light oil removed. Other results are maintenance of rather high specific gravity, which is sometimes required in coke oven gas. Maintenance of a definite volume of send-out gas with reduced coke production ; this is

valuable when coke stock piles are too large and gas must still be made. Increase in plant capacity for gas. This is accomplished by charging the oil in addition to the normal weight of coal and carbonizing in the same time. This is additional gas which can be secured at reasonable cost, limited by the quantity of oil which can be so carbonized. Increase in bulk density of the coal mix charged to the ovens, thereby increasing, or maintaining under all conditions, plant capacity for coal. Decrease in dust, moisture pick-up, and weathering of coals in storage or in transit.

In their final conclusion the Authors state that use of oil on coal has in no way deleteriously affected the products, such as tar, light oil, and coke. The Paper exemplifies once again the great flexibility of the carbonizing process.

CENSUS OF STEEL STOCKS

A COMPLETE census of the stocks of steel held by users is being taken by the Iron and Steel Control at the request of the Ministry of Supply. Forms have been issued relating to the stock position at the end of December, and it is hoped that the results of the investigation will be available within a few days. In addition to stocks, the total receipts and consumption of steel in the last quarter of 1940 are asked for. The lists of firms written to were built up from lists of customers of representative steel firms in each area, but although the number of firms approached runs into many tens of thousands, some important, though not necessarily large, users of steel may have been omitted. The Ministry consider it is most desirable that every user of steel should be covered by the inquiry and should be on the Iron and Steel Control's list of steel consumers ; consequently they hope that any who have not yet received the inquiry form will write without delay to the Iron and Steel Control, Hemingford, Alveston, near Stratford-on-Avon. Regular returns of current holdings are, of course, made by Government Departments, makers and stockists of any of the steel products, and structural engineers, so that already a considerable volume of information regarding stocks is available, but for obvious reasons the time has come to extend this ascertainment to stocks of steel in the hands of all users. Tinplate stocks in users' hands are not covered by the enquiry, as particulars of these are already in hand.

Accident Prevention

The Ministry of Labour and National Service has been giving special attention lately to the further development of that side of the Factory Department's duties dealing with the prevention of accidents and education for safety. In the " JOURNAL " of Nov. 20 we referred to the issue of a booklet entitled *Works Safety in Wartime* in the publication of which the Ministry and the National Safety First Association had collaborated, and we pointed out that even in the Gas Industry, where accident prevention has always received the most careful attention, there might be instances where the service outlined in the booklet would be of advantage. We have now received copies of the four leaflets mentioned in the booklet, and would commend them to the attention of the Industry. They are : " We Don't Want to Lost You . . .", an introduction to the fundamentals of works safety ; " Workers' Safety Code," a more detailed book intended to follow up the first ; " Blood Poisoning," a suitable guide for all employees ; and " Foreman's Leaflet," explaining how the foreman can best carry out the duties that fall upon him in connection with accident prevention. Copies of the leaflets can be ordered from the Industrial Accident Prevention Department, N.S.F.A., 426, Strand, Cheltenham.

A Friend in Need

" It may now be revealed " that, when the London office of the " JOURNAL " suffered on Dec. 29 from the enemy action which was concentrated that night on the City, great assistance was rendered members of our Staff by the fire squad of Messrs. Benn Bros., Ltd., publishers of the *Gas World*. Fire, which was still smouldering on the following morning, was got under control with the help of their stirrup pumps and much hard work, and finally confined to part of the roof spaces. We take this opportunity of expressing our gratitude to our friends who learned of our situation and put in an appearance at a time when the odds were somewhat against us.

Personal

On the occasion of the marriage of Mr. James Jamieson, Engineer and Manager of the Edinburgh Corporation Gas Department, the Staff and Employees presented Mr. and Mrs. Jamieson with a silver tea service, along with a personal gift of a handbag to Mrs. Jamieson. In his reply, coupled with a New Year message, Mr. Jamieson spoke of the pleasure of receiving so many messages of esteem and good wishes, and their appreciation of the gifts from the Department employees.

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Mr. HENRY LESSER, who has been President of the National Federation of Employees' Approved Societies for more than 20 years, has had the distinction of being included in the New Year's Honours List as an O.B.E. Mr. Lesser is engaged with the South Metropolitan Gas Company.

Obituary

Dr. Bernard Friedman

The funeral took place on Jan. 9, at Hampstead Cemetery, of Dr. BERNARD FRIEDMAN, whose sudden death we announced last week. Besides family mourners and Ascot employees, representatives attended from the principal National Bodies of the Gas Industry, and from the London Gas Companies. There were a large number of floral tributes from many of the host of friends whom Dr. Friedman had made in the Industry and in other spheres of his interest.

We were able last week only briefly to announce Dr. Friedman's death. The following particulars of his career will be of interest to many :

Born in 1882 at Riga, Dr. Bernard Friedman studied and took his degree of Doctor of Science at Riga Polytechnic—at that time one of

the most famous colleges in Russia. Although trained as an engineer, he showed considerable interest in banking, probably influenced in this by his father, who was Governor of the State Bank in Riga. He expressed an early desire to go to England, and this was realized in 1903 when he settled in Liverpool, holding a secretarial position at the Comptoir National d'Escompte de Paris. The outbreak of the Russo-Japanese war compelled him to return to Riga, and immediately after the end of the war he went to Moscow, where he made his home. Here he found very primitive conditions prevailing in various branches of public utilities. Keenly interested, he immediately set himself to study ways and means of improving these conditions, and visualizing the great possibilities, especially with regard to domestic cooking and water heating, he ultimately chose gas as his sphere of special study. Using new designs of burners, which made the use of gas for these purposes both practical and economical, his business in cooking stoves and water heaters soon began to flourish, and rapidly grew to become one of the leading concerns in the Russian Gas Industry.

The outbreak of the Great War in 1914, coupled with the subsequent revolution in Russia, necessitated the closing of this concern, with the consequent loss of everything Dr. Friedman possessed. It says much for his dynamic energy and forceful character that he did not let this discourage him. He resolved to take the first opportunity of leaving Russia, and after a period of many and considerable hardships, he succeeded in returning to England, and made his home in London.

Determined, as he was, to continue his work for the Gas Industry, he studied prevailing conditions here, and in 1927 founded the firm of Cookers & Geysers, Ltd., at 244, High Holborn—later Ascot House. Now so well known to many gas engineers and other members of the Gas Industry, Ascot House at that time consisted of the first floor only, with the Doctor's two sons, Leopold and Harry Friedman, as his assistants, and only a few employees. There is no doubt that the difficult introduction of new and almost revolutionary types of appliances to an Industry always conservative in the best interest of its consumers, proved a stern test of the tenacity and perseverance of this

remarkable man in the first few years. With the opening of a workshop at Hither Green, production started, and thanks to Dr. Friedman's unwavering confidence in his product, as well as the appreciation, keen understanding, and helpful advice of so many gas engineers throughout the country, the business began to flourish. The Hither Green works soon proved to be insufficient to cope with the volume of the work, and Dr. Friedman decided that expansion was necessary. In 1933, under the name of Ascot Gas Water Heaters, Ltd., the plans for a new modern factory were laid and the "Ascot" Works at Neasden, North Circular Road, now so well known to almost every gas engineer in the country, were completed in 1934, and extended to their present size in 1938.

Concentrating on gas water heaters only, the development of other appliances such as "Perfecta" gas thermostats, gas cookers, &c., were left to the original firm of Cookers & Geysers, Ltd. With the assistance of his son, Leopold Friedman, as Chief Engineer and Director, the Doctor continued his work of research right up to the last with a view to constant further improvement. His aim was not only to provide the ideal appliance from the consumer's point of view, but also from that of the gas undertakings. With broad vision he contended that education in all aspects of the problems of water heating by gas was the prerogative of the many and not of the few; that the fitter, the inspector, and even the consumer, should be conversant with detail. The instructional classes for gas fitters and others in the lavishly equipped lecture room, the conducted tours through all processes of manufacture at the Works, the publication of such well-known works as *Gas—the National Fuel* and *Flats—Municipal and Private Enterprise*, and many technical publications distributed to the Industry bear witness to this.

Always modest, Dr. Friedman was the first to acknowledge that his success was due to the helpful advice and guidance of his many friends in the Industry, to whose interests he had devoted himself. As employer, his charm of manner and sense of equal right for all endeared him to his staff. His study of the comfort and welfare of his workers, whether at their desks, machines, at meal times, or during social activities, was always foremost with him, in spite of the weight of other business he carried.

In appreciation of his life's work, Dr. Friedman's passing has come as a deep-felt loss to the Industry.

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Sir ALFRED MANSFIELD, formerly associated with Mansfield & Sons, Ltd., Birkenhead, has died, aged 70 years.

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The death occurred on Jan. 8, at Little Hadham, Herts, of Mr. JOHN WHITE HAMPSHEIR, Director and General Manager of Keith Blackman, Ltd. Mr. Hampsheir was 71 years of age.

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Alderman ERNEST HAMER, D.L., J.P., of Blackburn, who a few days ago was appointed a Deputy Lieutenant of Lancashire, died on Jan. 5. He had been a member of Blackburn Town Council for 30 years and presided over the Corporation Gas Committee for 12 years.

British Commercial Gas Association

Extract from the 29th Annual Report of the General Committee

THE Report covers the twelve months to September, 1940. When the Committee's previous report was submitted to members, the war had only been of a few months' duration, and it was largely a matter of conjecture as to the influence of the war upon the Industry in the future. Since then the Industry has shared with the public and with industry and commerce generally the effects of enemy aerial bombing, and it is satisfactory now to be able to place on record that ser ice to the public has been maintained, notwithstanding serious difficulties.

Finance

The accounts show that the Association's income for the year ended March 31, 1940, amounted to £76,213, as against a total of £120,558 in the previous year. It is a tribute to the Industry that there has been no falling off in membership to account for this diminution in income, which is due solely to a decrease in the amount levied upon subscribing undertakings. All members have continued to pay their contributions in full, but a refund was made in respect of the monies unspent by the Joint Bodies at the end of the financial year on March 31, 1940. This arose mainly because of the cancellation of the Association's national advertising campaigns in the Press. The sum refunded to members was at the rate of 2s. 11d. per million cu.ft. of gas made.

Expenditure was decreased under practically all headings, particularly that of publicity, as mentioned above. Under this heading £59,829 was spent during the year, as against £101,103 in the previous year. After bringing all income and expenditure into account, a balance of income over expenditure amounting to £5 12s. was carried forward.

Following the outbreak of war the Association's expenditure was carefully reviewed and reductions decided upon, but the full benefit of these will not be felt until the end of the current financial year on March 31, 1941, when total expenditure is not expected to exceed the sum of £42,250. This will provide for a refund to members of approximately 50% of the subscriptions paid in the current financial year on the basis of 10s. per million cu.ft. of gas made.

The Gas Salesman's Education Scheme account indicates that fees received for students enrolled for the Domestic Gas Salesmanship Course were considerably less than in the previous year, but this was to be anticipated in view of the difficulties of home study and the fact that many men had joined and are still joining the Forces.

Administration

Owing to circumstances dictated by the war, the usual Autumn Annual Meeting of members did not take place in 1939, but members delegated district representatives to transact the formal business of the Annual General Meeting at a meeting which took place at Gas Industry House on Dec. 13, 1939. On this occasion, Alderman Ernest Grimsley, J.P., Chairman of the Leicester Corporation Gas Committee, was elected President of the Association in succession to Mr. A. M. Paddon, and Messrs. Cash, Stone & Co. were re-elected Auditors for a further year. The meeting also approved the Association's accounts for the financial year ended March 31, 1939, and the 28th Annual Report of the General Committee.

In normal circumstances the Association would have accepted the President's invitation to go to Leicester for the Annual Conference last Spring, but under existing conditions the visit was deferred.

It is proposed that Alderman Grimsley shall be asked to continue in office for a further period. It is also proposed that Messrs. Cash, Stone & Co. shall be re-elected as the Association's Auditors.

In accordance with the Rules, the appointment of the Chairman of the Executive Committee was considered at the next meeting of that Committee following the Annual General Meeting. On this occasion, Mr. H. D. Madden expressed the view that he should not continue as Chairman for a further year, because he felt that the office, especially during wartime, demanded a Chairman who was more readily accessible than he was in Cardiff. Major Bywater intimated that in normal circumstances it would fall to him, as Vice-Chairman, to offer his services as Chairman, but as he had so many additional responsibilities placed upon him as a result of the war, he asked to be released from his obligations for the time being. This the Committee agreed to do. An invitation was therefore extended to Mr. W. J. Sandeman to accept the office of Chairman, and he was unanimously elected to that position. Mr. T. Brown took Mr. Sandeman's place as Hon. Treasurer, and Major F. J. Bywater continues to serve in the capacity of Vice-Chairman.

Having regard to the difficulties of travelling and the desire of members to remain in their districts during the emergency, the Executive Committee invested an Emergency Executive Committee, consisting of the Chairmen of the Districts, the Hon. Treasurer, and the Executive Chairman, with full powers to act on their behalf and on behalf of their Sub-Committees dealing with Finance, Publicity, and General Services. The Emergency Executive Committee has since met at intervals.

On the outbreak of war eight members of the Association's staff were called up to join the Forces, and other members of the staff have since left for military service. The Executive Committee appointed a Sub-Committee to go into the question of the Association's wartime staff, which now consists of 27 officers, clerks, and artists, with an annual wage and salary roll of £7,600 as against a total staff of 73 at the outbreak of war with a total salary and wage roll of £18,943.

Four of the Association's senior officers, including the Manager, Mr. W. D. Rowe, have been seconded for service with Government Departments. The staff serving with the Forces are receiving allowances from the Association.

National Press Advertising

On the outbreak of war all national campaigns in the Press were suspended. These were renewed in the early part of 1940, and dealt with the contribution of the Industry to the war effort, linked with the utilization of gas for heating and hot water. The advertisements drew adverse comment from the electricity supply industry, which influenced the introduction of the Joint Gas and Electricity Agreement, which will be referred to later in this report. The campaign was discontinued in May last, since when there has been no advertising at all by the Association in the Press, with the exception of a special series of advertisements in certain technical and trade papers, which produced many enquiries for copies of the Association's publication *A Thousand-and-One Uses for Gas*.

With the cessation of national advertising, editorial publicity has assumed even greater importance. This branch of the Association's work has received special attention, and it is satisfactory to record that notwithstanding smaller newspapers and the competition of war news, gas has been kept prominently in the Press throughout the year.

Among the special editorial campaigns which had successful results may be mentioned the William Murdoch Centenary in November,

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1939, the inauguration of the National Food Campaign in April, 1940, the " prestige " campaign supporting the Spring national advertising, and two Press conferences arranged for the London Gas Development Association on the subject of the use of gas for motor transport. Editorial material has been sent to the Press on fuel economy, gas pokers, the Gas Industry's films, communal cooking, and other subjects.

The Press have been ready to publish these editorials since they concerned matters of special interest to the public in wartime, and as a result many thousands of applications have been sent to the Association for our literature on these subjects. Members have been supplied also with editorials for their local newspapers on all new publications issued by the Association. The Association continues to be asked for contributions to the Press dealing with the Gas Industry in general, and on special subjects in particular.

While there has been a diminution in the volume of local advertising carried out by members, undertakings have continued to make use of the Association's local advertising service. Local advertisements are prepared and circulated to all members to link up with new publicity material issued by the Association.

The Joint Gas and Electricity Agreement

With the intensification of the war, it became apparent that it was in the national interest, and at the same time in the interests of the two industries concerned, that gas and electricity should come to an understanding on competitive selling. This resulted in an agreement known as the Joint Gas and Electricity Agreement, which provides that both gas and electricity undertakings should refrain from engaging in any activity which was derogatory to the interests of the other, and that machinery should be set up for the settlement of differences arising out of the agreement either locally or through headquarters in London. This agreement was circulated to all gas and electricity supply undertakings and consent has been general to observe its provisions. In accordance with the spirit of the agreement, the National Organizations of the two industries agreed to suspend national Press campaigns until further notice.

There have been several instances when infringements of the agreement have been satisfactorily settled by the operation of the machinery provided for this purpose. The agreement continues to function satisfactorily, and there is no evidence that either industry—whether locally or nationally—is failing to carry out its terms.

With a view to condensing the communications issued by the Association to members, to save their time now occupied by other urgent matters, and to economize in postage and paper, the Association introduced in the early part of the year the regular issue of Service Folders. These folders group the communications the Association desires brought to the notice of members, and have proved a success. The policy behind all the material prepared and issued to members, to the public, and to the Press, has been, first, to serve the national effort, and at the same time to keep the utilization of gas in the mind of the public and to preserve their goodwill.

B.C.G.A. Studio

The Studio has continued to provide many members with practical assistance in the arrangement of their showroom windows by supplying them with attractive and topical displays. The Studio has also maintained its regular services for the supply of double crown posters and showcards, and posters for the hoardings.

The total number of orders received by the Studio during the twelve months amounted to 1,848, while displays, which were issued bi-monthly instead of monthly as for the 1939 scheme, totalled 845 and included 14,798 double crown posters, 1,815 showcards, 679 hand-painted posters, and 330 sundry cut-outs and " Mr. Therms." Additional materials supplied to members from stock included poster frames, ticket holders, poster boards, battery-operated turntables, and 300 rolls of anti-splinter tape.

With a view to assisting members to meet requests for wartime lectures, the Association has prepared notes and lantern-slides on half-a-dozen different subjects. These are available on free loan with a nominal fee for hire of the lantern-slides. The Association has also arranged for members to have the services of the three following lecturers : Mr. W. A. Gibson Martin, Mr. T. Bowen Partington, and Mr. R. N. Webb. It is hoped that the Association's lecture service will be more freely used in the future as a means of maintaining public interest and goodwill.

In the absence of Press advertising, the Association's films assume considerable importance as a phase of national publicity. There is now a total of 27 different films in the Association's library. They are all available in 35 mm. or 16 mm., some having silent versions, and when these are issued a draft commentary accompanies them.

The number of borrowers of these films is rapidly growing, and during the past twelve months 2,500 reels of film have been loaned and shown to a total estimated audience of well over half-a-million.

Salesmen's Circles

Practically the whole of the Circles suspended activities immediately following the outbreak of war, but a number have since made efforts to hold occasional meetings mainly during the lighter months of the year, in an endeavour to avoid the inconvenience occasioned by travelling during the autumn and winter. It was not found possible to arrange the Annual Meeting of members of Gas Salesmen's Circles which is usually held in London in the spring of each year, but a meeting of Chairmen and Secretaries was held in Birmingham in May, at which matters of immediate interest affecting the work of the Circles were discussed.

The " Goodenough " Gold Medal has been awarded to Mr. W. M. Denman, of King's Lynn, a member of the Eastern Counties, Eastern Section, Circle, for his Paper entitled " The Standardization of Selling Prices," and eleven Silver Medals have been awarded for the best Papers given before other Circles during the 1939–40 Session. The difficulty of travelling and the call of the Services have made it impossible to continue with the Speech Training Competition this year.

NEWS OF THE WEEK

We are informed by Messrs. R. & J. Dempster, Ltd., that, in spite of " enemy action," the firm is in full operation.

The Coal & Shipping Office of the South Metropolitan Gas Company reverted entirely to 34, Clayton Street West, Newcastle-upon-Tyne, 1, on Wednesday, Dec. 4, 1940. Telephones 24685–24686.

The Bombay Gas Company, Ltd., whose city offices were destroyed by fire, have now taken offices at 279–281, Gresham House, Old Broad Street, E.C. 2. The emergency telephone number is Sanderstead 1553.

Burnley Gas Committee has decided that in respect of the application of the purchase tax to goods sold on hire purchase, the purchaser may have the option of paying the tax by instalments over any period less than but not exceeding three years.

The Underpressure Engineering Co., Ltd., has removed from Burgess Hill to more suitable and commodious premises at Mansfield, where the firm has all the facilities of an up-to-date foundry and machine shop with over 30 years' experience of underpressure work.

The members of Carlisle Corporation Gas-works Home Guard recently held a hot-pot supper at the Pheasant Inn, Carlisle. Mr. J. N. Routledge presided, and the guests included Mr. J. G. Aitken, Engineer and Manager. An impromptu concert was given by the members.

Hoylake Corporation Lighting and Heating Committee announces that increased costs have necessitated an increase of 10% in the price of gas, commencing after the December quarterly readings. The increase will bring the approximate price of gas to 4s. 8d. per 1,000 cu.ft.

Gas Chambers & Coke Ovens, Ltd., of Artillery House, Westminster, S.W. 1, announce that they have evacuated to Eridge, Sussex, and all communications should be addressed to their Emergency Offices at Eridge, near Tunbridge Wells, Sussex. Telephone numbers: Groombridge 120 and 121.

1940 has been a busy and successful year in every section of the Nottingham Corporation Gas Department in spite of the loss of the public lighting load. A feature has been the demand for factory heating and canteen equipment as the result of improved welfare conditions for workers. The showroom demand on the domestic side has been greater than ever, and only the limitation of supplies of apparatus has prevented record sales. The Department's demonstration theatre has been in constant demand, and over 8,000 people have attended cookery demonstrations and lectures during the year.

Moonlight Calendar

As a guide to the fixing of advance appointments, the Moonlight Calendar for 1941, issued by the Rawlplug Co., Ltd., Cromwell Road, London, S.W. 7, is a welcome gift to those who are compelled by business or other reasons to use the hours of darkness. It shows at a glance for each month of the year the hours of sunrise and sunset, and the periods of bright moonlight.

Mr. F. M. Birks, O.B.E., who, as announced in our Personal column last week, has been appointed Chief Engineer of the Gas Light & Coke Company in succession to Mr. R. W. Hunter. Mr. Birks has been Deputy Chief Engineer since January, 1936.

W-D Carbonising Development

Since the Woodall-Duckham Companies erected their first carbonising installation in 1903, their development has been

CONTINUOUS

Every improvement in design and in technique is most thoroughly investigated prior to its adoption; consequently radical changes are

INTERMITTENT

The Companies' technical organisation is devised to ensure that the scientific application of practical experience does not become

STATIC

As a result, Gas Engineers are offered the following three modern and efficient carbonising systems from which to select a plant suitable to their particular requirements:—

CONTINUOUS VERTICAL RETORTS

INTERMITTENT VERTICAL CHAMBERS

W-D

STATIC VERTICAL RETORTS

W-D

THE WOODALL-DUCKHAM VERTICAL RETORT AND OVEN CONSTRUCTION CO. (1920) LTD

Temporary Address:

UPLANDS · EPSOM ROAD · GUILDFORD

Telephone: Guildford 3301 (5 lines)

Members of the Society of British Gas Industries

Telegrams: Retortical, Guildford

T.G.S.

IT'S THE NEEDLES THAT COUNT

It's the needles that make the difference so noticeable in the Newton Needle Steam Heated Gas Heater. This use of needles on the element is a planned and patented principle. No other system can ensure a better heat transfer or a more negligible back pressure.

But these are not the only advantages. The elements are of a special cast iron so that you have no corrosion problems. Less tubes are necessary and less space is occupied. In actual fact the saving of space over other types is anything up to 40%.

The Newton Needle Gas Heater is built to last, so that considering how low is its initial cost, it is indeed an economical installation.

Send to-day for your copy of our illustrated brochure describing the Newton Needle Steam Heated Gas Heater.

NEWTON NEEDLE
STEAM HEATED GAS HEATERS
NEWTON CHAMBERS & CO LTD THORNCLIFFE NR SHEFFIELD

GAS SAMPLING AND TEMPERATURE MEASUREMENT IN FUEL BEDS*

By L. H. F. NICHOLS, B.A.

THE object of fuel bed investigations is to elucidate the phenomena of combustion with a view to the better design and more efficient working of plant. By measuring the variations of temperature and composition of the gas occurring in successive layers of the fuel bed previous workers have been able to study the effects of such factors as air blast rate and pre-heat, type and quality of fuel, and bed thickness.

In general, experiments were made with cylindrical fuel beds 12 in. to 20 in. in dia., and up to 4 ft. 6 in. in depth. Air was supplied through the grate on which the fuel rested, and in some instances provision was made for the removal of ash and clinker, depending on the duration of the test and the type of fuel used. In the experiments incorporating analyses of gases occurring at various distances from the grate ([1], [2], [3], [4], [5]) identical methods of investigation were employed. Water-cooled gas samplers of ¼ in. bore were inserted radially through the walls of the bed, and at fixed distances in most cases of 1½ in., 3 in., 4½ in., &c., from the grate. The tips of the samplers reached approximately to the central axis of the bed, except in the case of Mott's experiments, in which gas was withdrawn from points half-way between the central axis and the walls. This method combines the advantages of easy manipulation with minimum disturbance of the bed below the point of sampling. The gases were drawn by means of an aspirator or steam ejector through a small filter, and past tubes for sampling over mercury at constant rate.

Temperatures were measured at the point of sampling by means of an optical pyrometer sighted down the tunnel left in the bed by withdrawing the gas sampler. Suitable precaution were taken to prevent the escape of gas through the hole. Kreisinger ([2]) closed the hole with a cap incorporating a thin microscope slide, with a shutter to prevent the glass becoming coated with soot when the cap was being fixed in position. This shutter could be slid back before taking a reading. When the pyrometer was sighted on a tungsten filament lamp the microscope slide was found to have no effect on the reading. In addition to an optical pyrometer, Neumann used sheathed platinum, platinum-rhodium thermocouples.

In most cases the fuel, sized between 1 in. and 1½ in., was replenished intermittently. Kreisinger maintained a constant depth of bed by additions of fuel every one to five minutes, according to the air blast rate, whereas Mott, finding that frequent refuelling disturbed the bed temperatures in his experiments, allowed the fuel surface to burn down 2 in. before replenishing.

A Modified Type of Apparatus

In the course of some work on the factors controlling gasification in beds, such as are incorporated in portable gas producers, modifications were made in the technique of gas sampling and temperature measurement just described. A smaller sized fuel was used, and tests were carried out on a deep bed of square cross-section, with its central axis inclined to the vertical. The air blast was supplied to the upper surface of the fuel and passed down through the bed to the flue. The depth of the fuel was maintained continuously, and the bed conformed to the definition of an "Equilibrium Fuel Bed" given by Nicholls and Eilers.†([5]) Probes for temperature measurement and gas sampling were inserted up into the bed through the grate on which the fuel rested.

The fuel bed was bounded by 4½ in. of fire-brick encased in a welded sheet metal box (see fig. 1), and was enclosed at the top by a water-cooled lid. The axis of the bed was inclined to the vertical at an angle of about 45°. The air blast was supplied through a 3-in. hole centrally disposed in the lid, and suitable flue connexions were made from the bottom of the box to convey the gas to a chimney. A small hopper was arranged vertically above the box to feed fuel to the bed through a rectangular shaft of cross-section 9 in. by 3 in., separated from the water-cooled lid by one brick thickness. By setting the inclination of the central axis for a particular size and type of fuel, the fuel surface could be maintained parallel to the lid. Air was able to enter the bed across its whole surface.

* From the *Journal of the Institute of Fuel*.

† A fuel bed which for a constant rate of primary air maintains the same character of combustion and thickness.

Probes ½ in. in dia. could be inserted into the bed through five glands which were brazed to the bottom of the box. One probe was inserted up the central axis of the bed, and the other four symmetrically on either side at distances of ½ in. and 2 in. from the brick walls. The probes thus lay in a plane dividing the bed in halves. A mica window was provided in the pipe supplying the air blast, in order to observe the fuel surface. Experiments were mainly conducted on fuel sized between ¼ in. and ⅜ in.

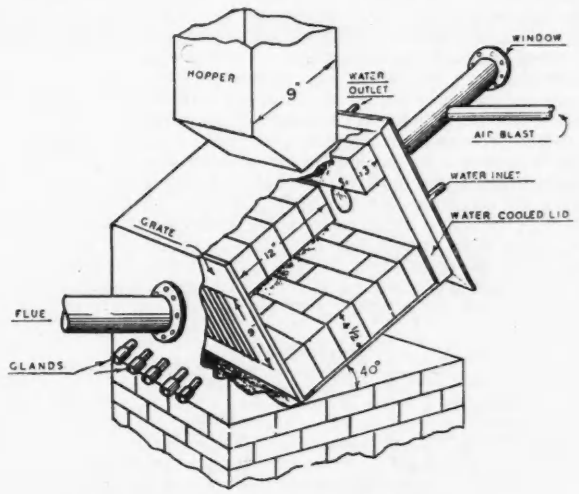

FIG. 1. GENERAL ARRANGEMENT OF FUEL BED

Gas Sampling

A water-cooled gas sampler (fig. 2) of $\frac{1}{16}$-in. bore was employed, similar in construction to that used by Kreisinger. The ¼-in. dia. tube at the end of the sampler was closed by a rubber bung, gas being withdrawn through the small side tube. When it was required to move the sampler up or down the bed, the inner tube was kept clear of dust and soot by removing the bung and pushing to the tip an 18 s.w.g. springy steel wire. The wire could be quickly removed and the bung replaced before taking a sample. By using a tube of $\frac{1}{16}$-in. bore the smaller particles of fuel were prevented from being drawn into the sampler, and the velocity of travel of gases was made very large, increasing the heat transfer to the water-cooled surface.

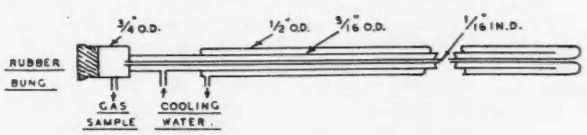

FIG. 2. WATER COOLED GAS SAMPLER

In order to facilitate control of the rate of gas sampling, a small exhauster was used, which was designed to deliver a maximum of 3 cu.ft./min. when working at atmospheric pressure, and which was capable of producing on the vacuum side a reduction in pressure of 60 cm. of mercury. This exhauster was fitted with three brass vacuum cocks, one of which was used to control a by-pass back from the outlet (fig. 3), and by adjusting the other two, gas could be drawn from the water-cooled sampler or from the flue. The gases withdrawn through the sampler passed through a small filter and a capillary flow gauge to the exhauster. They were then circulated past Orsat analysis apparatus and gas sample tubes, through another flow gauge, and finally through a gas cock to the flue. Comparison of the

readings of the two flow gauges gave an indication of the rate of withdrawal of gas from the line into the sampling tubes. The gas cock just before the flue was used to adjust the pressure in this part of the line. A pressure of about 15 in. water-gauge above atmospheric was found most convenient for filling the Orsat apparatus. The rate of withdrawal of gas from the bed was also independent of the rate of filling of either the sampling tubes or the Orsat apparatus, and could be kept practically constant whether or not the tubes were being filled. A mercury barometer was included to indicate the extent of blocking of the sampler. When blocking occurred sufficiently to produce a suction of over 3 in. of mercury the cock controlling the rate of sampling was closed and the innermost tube of the sampler cleared again by means of the steel wire.

The low pressure side of the line was tested for leaks by closing the tip of the sampler and exhausting the apparatus until the mercury rose 2 ft. in the barometer. When the cock controlling the sampling rate was closed, no drop in height of the mercury could be detected after half an hour.

Experiment was made on the time lag between the entry of gas into the sampler and delivery of gas of the same quality to the Orsat apparatus. To do this, town gas and air were supplied alternately to the sampler. The town gas was analyzed directly before and after this experiment to ensure that its composition was maintained. The lag was found to be less than ¼ minute, which was considered to be quite small enough.

When probing from the base of the bed, it is only necessary that withdrawal of gas should not disturb the course of the blast through that part of the bed just before the sampler. Were the sampling rate too high, gas might be drawn faster through the bed in the immediate neighbourhood of the sampler or from a wider region than the sample was intended to represent. On the other hand, no interference would be caused by a very slow rate of sampling, as in this case the gas stream would spread round the sampling tube as round a particle of fuel.

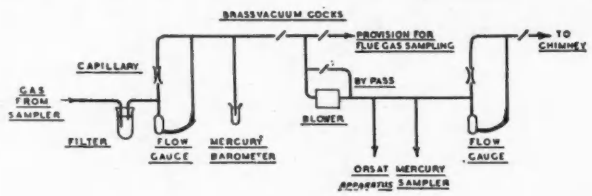

FIG. 3. DIAGRAM OF GAS SAMPLING ARRANGEMENT

Owing to the increase in volume of the blast on gasification and heating up, it is difficult to estimate the maximum sampling rate allowed by the above considerations. The sampling rate chosen was justified by the following test: The sampler was inserted to a point near the fuel surface where the variation of gas quality with distance is rapid, and gas was withdrawn at different rates. Gas withdrawn at twice the speed chosen for the experiments was found to have the same composition as that withdrawn at the normal rate.

On observation through the mica window it was found that the water-cooled gas sampling tube had little disturbing effect on the fuel. To the eye, the temperature of particles of fuel touching the tube was only affected at the points of contact with it. When the tube was pushed through the surface of the fuel a very shallow hump, about the width of four particle diameters, was formed. This hump only became noticeable when the sampler actually broke the surface. The effect was so small while the tip of the sampler was still in the bed that it was not thought to introduce an error in measurement of distance from the fuel surface of more than ⅛ in. A far greater variation of gas quality than would be accounted for by such an error in measurement was sometimes found at points near the fuel surface. It is thought that these differences were governed by the orientation of individual particles on the surface and by local fluctuations in temperature, rather than by the method of sampling. Some justification for this assumption is given later.

It is obviously of the utmost importance that the sample delivered for analysis be representative of the gas at the point of sampling. The most likely change in composition to occur would be a reduction in the amount of carbon monoxide due to burning in excess oxygen present in the sample. Fairly good evidence that this does not occur is afforded by the occurrence of about equal quantities of carbon dioxide, carbon monoxide, and oxygen in some samples very near the fuel surface. The water-cooled sampler was therefore considered to provide sufficiently rapid cooling, as previous workers have also found, to prevent burning of carbon monoxide in the sampled gas.

Temperature Measurement

There are two main methods of measuring temperature in a fuel bed—namely, with an optical pyrometer and with sheathed thermocouples. The use of an optical pyrometer presented some difficulties in this experiment. Other workers, using larger sized fuels, poked a hole in the bed and sighted the pyrometer down this hole. In this bed, however, on poking from one of the glands in the bottom of the box, no channel was left, and it was necessary to insert a refractory tube up which to sight the pyrometer. A closed-end tube had to be used owing to the tendency of particles of fuel to fall and stick a little way down the tube, rendering uncertain any estimate of the position at

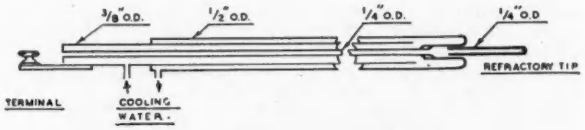

FIG. 4. WATER COOLED PYROMETER.

which the reading was made. For this purpose a refractory sheath ⅜ in. in dia. and 11 in. long, secured with fire cement into a drawn steel tube ½ in. in dia., was used.

There were two other possible alternative positions in which to use the optical pyrometer—through the water-cooled lid and through the side walls of the bed. With a refractory tube inserted through the water-cooled lid there would be no difficulty involved due to the particles of fuel entering the tube, but the gas reaching the point observed from the fuel surface would have passed down the side of the tube, instead of purely through the natural voids in the bed, and this might not give temperatures truly representative of that part of the bed. It was thought also that insertion of a sufficient number of tubes through the side walls to obtain a good picture of the variations in temperature in a bed of this size would upset the natural flow of the gases and fuel.

Temperatures were more easily measured with sheathed platinum, platinum-rhodium thermocouples inserted through the glands. A water-cooled pyrometer, having at its tip a sheath of recrystallized alumina, which would withstand a temperature of over 1,900° C. for short periods, was designed for these experiments. The sheath was 3 in. in length, and only ¼ in. in diameter, to minimize disturbance of the bed at the point of measurement. Unlike the case of the gas sampler, the reading obtained with the pyrometer depends on the particles surrounding the tip of the probe, as well as on the fuel immediately in front of it.

A test was made to determine the amount of heat withdrawn from the bed by one of these pyrometers when the tip was at the hottest part of the bed, and when the air blast rate was low. The amount of cooling water supplied was reduced until its exit temperature was about 45°C., and the temperature rise and quantity of water flowing were measured. An estimate based on the calorific values of the fuel and the gas produced, and on the rate of gasification, showed that about 13%* of the total heat liberated in the bed would be withdrawn by four such water-cooled pyrometers and the gas sampler. Deducting from the total heat generated the heat radiated to the water-cooled lid, it was shown that the five probes would remove 17% of the heat passing down the bed and through the side walls. In order to find whether this would have any serious effect on the bed and its time of recovery when the probes were withdrawn, the following test was carried out: With the bed in a normal steady condition, a survey of temperatures was made, using all four pyrometers, and the probes were then left with their tips at 6 in. from the lid for 15 minutes. One of the probes was withdrawn to 12 in., and readings were taken with it in rapid succession until a constant temperature was reached. Occasional readings on the probes still at a distance of 6 in. from the lid were made to ensure that the conditions in the bed remained unaltered. The time of recovery was found to be the same for the thermocouples near the walls as for those in the centre of the bed, and was longest with the lowest air blast rate used (20 cu.ft./min.). In all cases the final temperatures reached were the same as those measured in the preliminary survey.

By means of the pyrometers, readings were taken along four lines in the plane containing the probes, and curves showing

* This percentage was, of course, smaller when the probes were drawn back from the hottest part of the bed.

variations of temperature with distance from the fuel surface were plotted. Isotherms, from which the temperature at the tip of the gas sampler was deduced, were then constructed from the above curves.

The tips of these pyrometers had no appreciable effect on the bed. Looking through coloured glass, it was not possible to detect the outline of the sheath until it was level with the surface. Parts of the cold gas sampler could be seen through the voids in the bed, sometimes even when over $\frac{1}{4}$ in. from the surface.

It has been mentioned above in connexion with gas sampling that fluctuations in temperature may occur at any one point. This has been illustrated by the pyrometers which show that temperatures in a line near and parallel to the fuel surface vary independently by as much as 20°C. in 15 seconds. This fluctuation was not detected in earlier tests using pyrometers with sheaths $\frac{3}{8}$ in. in diameter.

References

1. Neumann.—*Forschung*, 1913.
2. Kreisinger, Augustine and Ovitz.—U.S. Bureau of Mines Tech. Paper 137 (1916).
3. Mott and Wheeler.—*Coke for Blast Furnaces* (1930).
4. Nicholls.—U.S. Bureau of Mines, Bulletin 378.
5. Nicholls and Eilers.—*Trans. A.S.M.E.*, vol. 56, 1934.

DISTRIBUTION OF GAS IN A MINING AREA

By CHARLES R. INGHAM,

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MINING subsidence is due to the working of coal seams and the subsequent settlement after removal of the coal. It is very noticeable when thick shallow seams are worked, as is the case in a large part of the Cannock area. Subsidence occurs in wave formation with the result that part of the affected area may be under tension and part under compression. Fig. 1 shows the effect of such compression on an 8 in. steel main with welded joints. Figs. 2 and 3 show a damaged service and cast iron main.

Canal bridges are a very notable feature of the landscape. The level of the water in the canals is determined by the levels of locks in adjacent areas where there is no subsidence, with the result that as subsidence takes place it becomes necessary to raise the banks of the canals and to raise bridges in order to provide the necessary head room for barges and horses. The approach at each side of the bridge becomes very steep, and the writer well remembers one occasion when, taking a short cut across minor roads, he came to a canal bridge which he failed to surmount in bottom gear !

There is another difficulty in mining areas due to the practice of giving " allowance " coal. A married coal miner receives nearly a ton of coal every month free of charge at the pit, only the cost of delivery being to pay for. The desire to have an all-mains wireless set leads the miner to consider having electricity installed. On enquiry he learns that this will cost him several pounds, but if he will consent to have a number of lights installed on the " assisted wiring " system he can have electricity installed for nothing. Bang goes the gas lighting load ! The poor gas engineer then turns to the cooking or heating load to recompense him for the loss of the lighting, only to find that he is competing with a free article in the shape of " allowance coal." What one may call the " convenience factor " is the only card left to play, but it is remarkable what can be sold under these conditions, and one realizes very fully that one is selling a service as well as a commodity. The average quarterly consumption is about 8 therms per consumer, which does not allow much scope for promotional tariffs. Mining areas often consist of long straggling villages with long stretches of open country between. These conditions, low consumption per service pipe and long lengths of main per consumer, tend to give a high unaccounted-for gas figure. When they are coupled with mining subsidence such as occurs in the Cannock Chase Coalfield it becomes a certainty. The Cannock Company's figure is about 23%. It is not suggested for one moment that

Fig. 1.

Fig. 2.

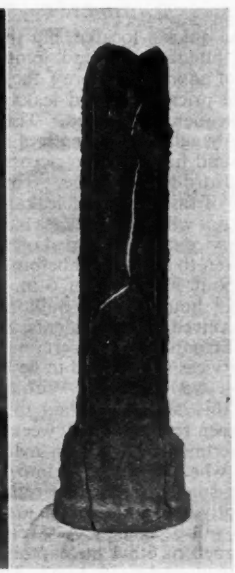

Fig. 3.

Fig. 1 shows the effect of compression on an 8 in. steel main with welded joints.
Figs. 2 and 3 show a damaged service and cast iron main.

this high figure is inevitable. Considerable effort is being made to reduce it, but there is little doubt that under the conditions described a fairly high figure must be expected.

The effects of mining subsidence are not always seen at once. It is necessary to look for signs, such as cracks in roads, footpaths, walls, and buildings, damage to vegetation, accumulation of water on the surface, and changes in the volume of water found in syphons. The whole of the mains of the Cannock area are patrolled constantly, with special emphasis on the worst areas. One man has this as his sole duty. There are normally two gangs of men testing for and dealing with escapes, but at some times there may be four or five gangs on this work.

Records are kept of all leakages under the headings of broken mains, drawn joints, broken services, and these are indicated on a map of the district by means of pins with different coloured heads for each class of job. The map is photographed each year, and the pins are removed ready for insertion during the subsequent year. Figs. 4, 5, and 6 show very clearly how trouble is centred in certain well-defined areas, but there are some indications of movement of the trouble centres, although this may be partly due to concentration on work in certain areas in any one year. It is hoped that as time goes on these photographs will have considerable value.

One might think that by keeping in touch with the Colliery Companies and thereby getting to know what areas are being worked, it would be possible to anticipate the worst subsidence and deal with escapes very promptly. This has not been found to be the case, as subsidence frequently occurs within a few weeks of mining operations commencing, and may continue for years.

The worst leakages are not the large ones, as those are soon reported and quickly located, but the small ones caused by the drawing of hundreds of lead joints small distances, such as one-eighth of an inch or more ; these are difficult to detect and locate. The pricker-bar and leakage indicator method is the one most frequently adopted. This method is often coupled with that of bagging-off a length of main at each end (if it is fed both ways) and fixing a rider across with a meter in series, in this way measuring the leakage. This is, of course, an absolutely certain way of discovering if leakage is taking place, and will give clear proof when all leakages have been stopped. Needless to say, all service taps are turned off by our own men and proper warnings given to consumers before testing. A recent test of a length of about 500 yards of 6 in. main showed a leakage of 420 cu.ft. per hour—over 3 million cu.ft. a year. No report had been received from residents, nor was there any obvious indication of trouble beyond certain unevenness in road surfaces. About 16 services were found to be broken off and two or three mains joints were drawn. Within six weeks of curing all leakage on this length we had to repair two of the services which had been repaired a few weeks earlier.

Some experiments have been made using an odorant (ethyl mercaptan), which is dropped into the main in the hope that the offensive smell would cause reports of leakage to be made more promptly. Results so far are not conclusive and more experiments will be made. A specially trained dog, trained to follow the smell of ethyl mercaptan, has been purchased, and trials have been made with him. The results are inconclusive, as it has been impossible to do much work as yet owing to labour difficulties, loaning gangs to bombed undertakings, &c. In any case it is necessary to understand a dog's limitations for this work. When the dog smells a leak he tries to scratch the ground with his paws in order to find the object which has this interesting smell. If he is working on a hard road surface he finds that scratching hurts his paws and soon desists. It seems, therefore, that it will be necessary to use a pricker-bar. In that case we might as well use a leakage indicator, and there would be no advantage in using the dog unless he is found to be more sensitive. If work is done on freshly tarred surfaces it is likely that the smell of the tar will interfere with the dog's sensitivity to the smell of mercaptan. Perhaps also windy weather will interfere with his work. On the other hand, where mains are laid in the grass verges of country roads or across fields there seems reason to hope that the dog may save time and money, and, similarly, he should be helpful in tracing leakages in service pipes passing through gardens, &c. Up to the present the best method we have found is to measure the leakage and trace it with the pricker-bar and indicator. A stretch of a few hundred yards is tested ; if leakage is indicated by the meter the length is split up into two or more sections and each section tested separately. Splitting a length of main into sections in this way often saves a good deal of unnecessary work.

Drawn lead joints can be recaulked and made tight, but they are liable to be drawn again in perhaps only a few days' time. To relay the mains with welded steel would be expensive and there would still be the problem of broken services. The solution (if it can be called such) which we have adopted is to recaulk the joint, leaving the face of the lead about half an inch from the face of the socket, and to fit a Dresser Clamp. This holds a specially shaped rubber gasket wedged against the side of the pipe and the face of the socket. The device has been tested, and it was found that when fixed on a 4 in. main it remained gastight when the spigot was withdrawn several inches from the socket. In fact it remained gastight even while the pipes were moving. This type of joint allows of considerable angular movement. For nearly three years we have fixed these couplings on drawn joints, and we have yet to find the first joint which has leaked after this treatment.

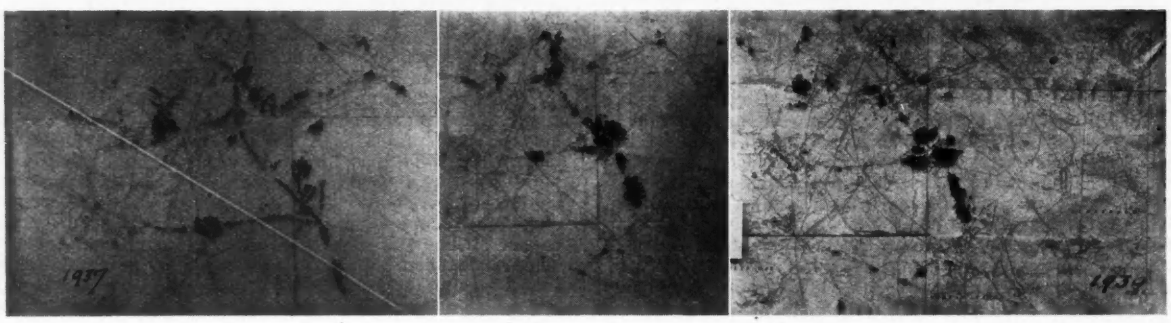

FIG. 4. FIG. 5. FIG. 6.

Figs. 4, 5, and 6 show clearly how trouble is centred in well-defined areas.

All new mains are steel. We weld the joints (of the long-sleeve type) of about 50 yards of main on the ground above the trench and then lower into the trench and connect up with a Dresser Coupling. This method has the advantage of allowing movement against compression or tension together with granting the best facilities for good welding by allowing the welder to turn the pipe over on the ground as the welding proceeds.

Service pipes are fitted with at least one Dresser Service Coupling. This is similar in operation to the mains coupling. There is a limit to what can be done in the way of protecting services as there seems to be no easy way of dealing with the shearing and bending stresses which occur in these pipes near their junctions with the mains. If we could use flexible metallic tube for the connexion between main and service (taking due precautions against water logging), it would be a great help to us. If any manufacturer can offer a flexible tube which will stand against soil conditions and remain gastight without kinking when movement occurs, I should be glad to hear from him. Electric cables are laid with occasional loops of slack which is taken up when subsidence occurs, and it may be that cable manufacturers could offer a suitable flexible pipe. Enquiries are being made.

The Cannock area is subjected to exceptionally severe conditions, and by virtue of this fact it is a very suitable experimental ground. If this brief account of these conditions leads any reader to make useful suggestions as to improvements in methods or materials, I shall be very grateful and will be prepared to try them out in practice if they appear to be suitable.

THE HYDRAULIC SEAL IN GASHOLDER CUPS

A Paper to The Institution of Gas Engineers

[Communication No. 236]

(*Continued from p. 68*)

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VII DETERMINATION OF WATER LEVELS IN CUPS

In order to determine the various critical positions of the water levels in the cup and dip and tank, it is first desirable to draw out the effective cup and dip section to a fairly large scale (about half full size). A line drawing only is all that is required, but care must be taken to see that the distances from the top of the dip channel to the lip of the cup plate, and from the bottom of the dip plate to the underside of the cup channel, are accurately drawn and generally in accordance with the requirements indicated in Figure 3. The thickness of the cup and dip channels and plating, however, need not be indicated, as the water levels are not considered in any way dependent upon these features. As variations in the level of the water in the tank affect materially the levels of the water in the cups of the lifts during the process of uncupping and cupping, it is necessary to prepare two sets of diagrams for the cup of each lift, indicating the various critical stages for the highest and lowest possible positions of the water levels in the tank.

In the following treatment of the subject, all pressures of gas, distances between water levels, movement of lifts, and dimensions of the cup and dip compartments, are given in inches.

First Critical Stage (I)

As a lift is deflated, the first critical stage is reached when the underside of the cup of the subsequent lift touches the water inside the holder. The water level at this point is some few inches below the level of the water outside the floating lift and varies according to the pressure thrown by the inflated holder. The difference in levels of the water in the cup of the fully inflated lifts is always equal to the difference in levels of the water inside and outside the floating lift. When the first and subsequent critical stages are reached and gas is trapped in the dip, the same axiom applies in relation to the pressure of the confined gas, i.e., the difference in levels of water in the cup is always equal to the difference in level of the water outside the cup plate and the water level in the tank outside the hanging or landed lift. In order to ascertain the exact positions of the water levels in the cup as the first critical stage is approached, it is necessary to determine the lowest position of the water level in the exposed portion of the cup. If the letters A, B, C, T and H refer to the various compartments of the cup and tank as shown in Figure 10, then the positions of the water levels in these compartments for the first critical stage may be conveniently represented by the terms A_1, B_1, C_1, T_1 and H_1, respectively.

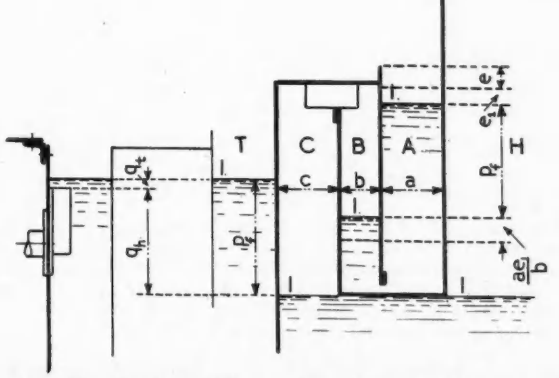

FIGURE 10.—*Typical Position of a Cup and Water Levels when Investigating the First Critical Stage.*

As the water in the exposed portion of a cup (compartment A) may be subjected to high winds and also to evaporation, the water level A_1 in a cup of a fully inflated holder is taken as being a distance of $e = 3\frac{1}{2}$ to 4 in. below the point of overflow on the dip channel. In cases where the dip plate is extended some distance above the dip channel, the distance e will be measured from the top edge of the plate, but where holes or water offtakes are provided at intervals through the extended portion of the plate, the distance e should be made not less than 3 in. from the bottom of the dip overflow to the water level in the exposed portion of the cup. Figures 11 (a), (b), (c) and (d) indicate the method of determining the

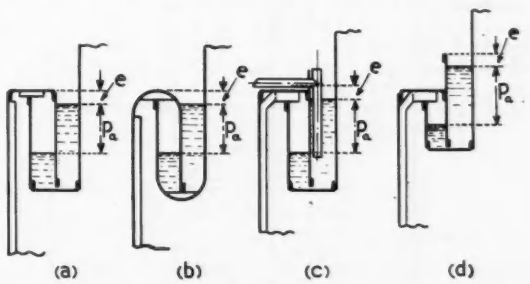

FIGURE 11.—*Relative Positions of the Water Levels in Cups of Various Types when Lifts are Fully Inflated.*

first positions of the water level in the cup compartment A for various forms of cups and dips.

As a lift is deflated and comes to rest in the tank, the levels of the water in each cup compartment A of the inflated lifts will fall, and further falls of the water level in compartment A will take place as the successive lifts are grounded. The distance the water level in any cup compartment A of an inflated lift will fall under these conditions may be represented as a function of the pressure difference between the fully inflated holder and each lift as it is grounded. The actual fall of the water level in any cup compartment A, due to the grounding of one or more lifts, may therefore be determined from the following expression:

$$p_f + e_1 + \frac{ae_1}{b} = p_a$$

where e_1 = the fall of the water level in cup compartment A, when a lift or a number of lifts have previously landed,

a and b = the widths of the cup compartments A and B, respectively.

On equating the above expression for e_1, the following is obtained:

$$e_1 = \frac{p_a - p_f}{1 + \frac{a}{b}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

The difference in water levels in the cup compartments A and B of inflated lifts, and the tank compartments T, C and H, may be stated thus:

$$A_1B_1 = T_1C_1 = T_1H_1 = p_f \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

Equations (4) and (5) enable the water levels in the various cup and tank compartments to be determined as the first critical stage for each cup is approached during the deflation of the lifts.

It is desirable first to investigate the critical positions of the water in the cup of a descending lift when the tank water levels T_1 and H_1 are at their highest points. This will determine the most unfavourable conditions to which the cup may be subjected so far as "blowing" during the uncupping operation is concerned.

The positions of the water levels in the cup and tank compartments for the first critical stage are shown diagrammatically in Figure 12.

SECOND CRITICAL STAGE (II)

To ascertain whether critical stage (II) exists (i.e., whether the water in the cup will eventually over-run the dip), it is necessary to determine the relationship between the distance

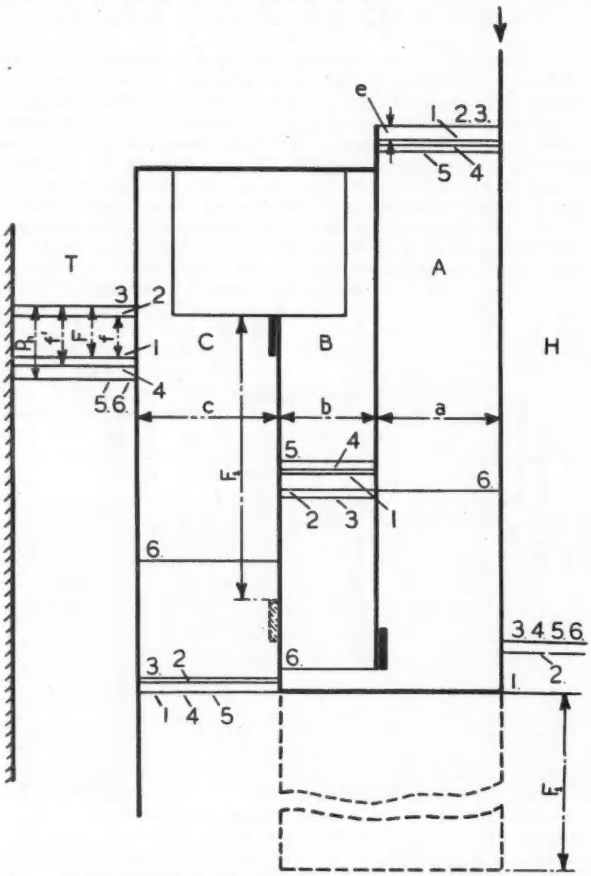

FIGURE 12.—*Typical Diagram of an Effective Cup and Dip Section Showing Critical Positions of the Water Levels I to VI.*

the dip will descend from critical stage (I) and the movements of the water levels in the various compartments of the cup and dip under consideration. Let the positions of the water levels in the cup and tank compartments A, B, C, T and H for the second critical stage be represented by the terms A_2, B_2, C_2, T_2 and H_2 respectively. Then the distances between the water levels in the various compartments for the first to the second critical stage may be expressed by the nomenclature (A_1A_2), (B_1B_2), (C_1C_2), (T_1T_2) and (H_1H_2). It will now be seen that as the dip descends further into the tank, the water level in compartment C rises relatively to the cup, owing to the increasing pressure on the trapped gas contained in the dip. This pressure increase is balanced by a corresponding change of the levels of the water in cup compartments A and B. The water level in compartment B will fall, while the water level in compartment A will rise relatively to the cup. The rise of the water levels (C_1C_2) and (A_1A_2) and the fall of the water level (B_1B_2) are dependent upon the widths of the cup and dip compartments. If a, b and c denote the widths of compartments A, B and C, respectively, the relationships existing between (A_1A_2), (B_1B_2) and (C_1C_2) may be stated as follows:

$$(A_1A_2) = \frac{b(B_1B_2)}{a} \quad \ldots\ldots (6)$$

also $$(B_1B_2) = \frac{a(A_1A_2)}{b} \quad \ldots\ldots (7)$$

and $$(C_1C_2) = \frac{b(B_1B_2)}{c} = \frac{a(A_1A_2)}{c} \quad \ldots\ldots (8)$$

Now suppose the dip to descend a distance f, from the first critical stage to the second critical stage.

Then $p_f + (A_1A_2) + (B_1B_2) = p_f + f - (C_1C_2)$

Therefore

$$f = (A_1A_2) + (B_1B_2) + (C_1C_2)$$

or $$f = (A_1A_2) + \frac{a(A_1A_2)}{b} + \frac{a(A_1A_2)}{c} \quad \ldots\ldots (9)$$

For the second critical stage to obtain, it is obvious that the level of the water A_2 must be in line with the top of the dip channel or point of dip overflow, so that the water is about to overflow from the cup. This condition may therefore be stated as follows:

$$(A_1A_2) = (e + e_1) \quad \ldots\ldots (10)$$

Substitution of the value (A_1A_2) in equation (9) enables the distance f to be ascertained. Now let F represent the distance the cup and dip descends from the first critical stage to the position where the hanging lift just touches the rest blocks. Then for this second critical stage to exist, the condition F>f must obtain. If F>f, the water levels A_2, B_2, C_2 for critical stage (II) may now be indicated in their respective positions in relation to the effective section of the cup and dip. The distances of these levels from the previous levels A_1, B_1, C_1 are then made equal to the values obtained from equations (10), (7) and (8) respectively. The positions of the water levels T_2 and H_2 may also be indicated on the drawing of the effective cup section from the expressions

$$(T_1T_2) = (H_1H_2) = f \quad \ldots\ldots (11)$$

The water levels A_2, B_2, C_2, T_2 and H_2 are shown in Figure 12. If it is found that F<f, then critical stage (II) does not obtain, and in this case the third critical stage is approached directly after leaving critical stage (I). The third critical stage will now be considered.

THIRD CRITICAL STAGE (III)

As the holder is deflated and the cup descends further into the tank, it will be observed from the diagram in Figure 9 that the approach to the critical stage (III) may be directly on leaving critical stage (I) or, alternatively, after leaving critical stage (II). If F>f, then it is clear that critical stage (III) will follow critical stage (II) and the positions of the water levels in this case may be found as follows:

Let the positions of the water levels in the cup and tank compartments A, B, C, T and H for the third critical stage be represented by the terms A_3, B_3, C_3, T_3 and H_3 respectively. Then the distances between the water levels in the various compartments for the second to the third critical stage may be expressed by the nomenclature (A_2A_3), (B_2B_3), (C_2C_3), (T_2T_3) and (H_2H_3). Allowing the cup and dip to descend further into the tank after reaching critical stage (II), it will be seen that the water level in compartment C will rise relatively to the cup, while the water level in compartment B will fall. The water level in compartment A will, however, remain at the same height at the point of overflow on the dip channel. The downward movement of the cup and dip from critical stage (II) to critical stage (III) will be equal to (F−f), so that the relationship existing between this expression and the terms (B_2B_3) and (C_2C_3) may be stated thus:

$$(T_2C_2) - (C_2C_3) + (F - f) = (A_2B_2) + (B_2B_3)$$

but

$$(T_2C_2) = (A_2B_2)$$

Then $$(B_2B_3) + (C_2C_3) = (F - f) \quad \ldots\ldots (12)$$

Also $$(C_2C_3) = \frac{b(B_2B_3)}{c} \quad \ldots\ldots (13)$$

Therefore

$$(B_2B_3) + \frac{b(B_2B_3)}{c} = (F - f) \quad \ldots\ldots (14)$$

The value of (B_2B_3) when F and f are known, may be ascertained from equation (14). The value of (C_2C_3) may now be determined from equation (13). Since the water level A_3 remains at the same height as A_2, then $(A_2A_3)=0$. The water levels in compartments T and H will rise a distance relative to the cup and dip equal to (F−f), so that

$$(T_2T_3) = (H_2H_3) = (F - f) \quad \ldots\ldots (15)$$

Positions of the water levels A_3, B_3, C_3, T_3 and H_3 may now be indicated as shown in Figure 12.

If the condition F>f does not obtain, but F≦f, then critical stage (III) is approached directly on leaving critical stage (I). In this case, the movements of the water levels to positions A_3, B_3, C_3, T_3 and H_3 will be similar in direction to those previously described. Let (A_1A_3), (B_1B_3), (C_1C_3), (T_1T_3) and (H_1H_3) represent the vertical distances through which the levels of the water in compartments A, B, C, T and H will move from their previous positions A_1, B_1, C_1, T_1 and H_1 respectively.

Then $(A_1A_3) + (B_1B_3) + (C_1C_3) = F$ .....(16)

Also $(A_1A_3) = \frac{b(B_1B_3)}{a}$ .....(17)

and $(C_1C_3) = \frac{b(B_1B_3)}{c}$ .....(18)

Writing equation (16) in terms of (B_1B_3), the following is obtained:

$$\frac{b(B_1B_3)}{a} + (B_1B_3) + \frac{b(B_1B_3)}{c} = F \quad \text{.....(19)}$$

As the value of F is known, the values of (B_1B_3) may be found from equation (19), and the subsequent values of (A_1A_3) and (C_1C_3) are also readily determined from equations (17) and (18). The water levels in compartments T and H will in this case rise a distance relative to the cup and dip, equal to F, so that

$$(T_1T_3) = (H_1H_3) = F \quad \text{.....(20)}$$

The water levels A_3, B_3, C_3, T_3 and H_3 may now be indicated in their respective positions as shown in Figure 13.

As critical positions (II) or (IV) may not necessarily obtain in some cases when lifts uncup, two diagrams showing the water levels for the various critical stages have been prepared. The diagram in Figure 12 indicates the water levels in the cup and tank for all six critical stages, while the diagram in Figure 13 shows typical positions for the water levels when the critical stages (II) and (IV) do not occur.

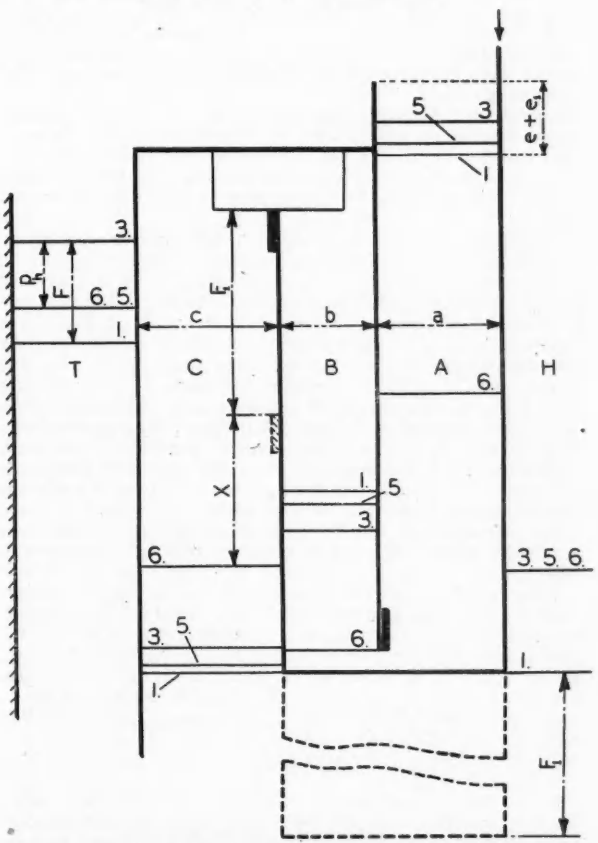

FIGURE 13.—*Typical Diagram of an Effective Cup and Dip Section Showing Critical Positions of the Water Levels I, III, V and VI.*

FOURTH CRITICAL STAGE (IV)

In order to ascertain whether critical stage (IV) exists (i.e., whether the trapped gas in the dip will eventually commence to blow under the cup channel as the hanging lift is landed) the relationship between the fall in gas pressure due to the landing of the hanging lift, and the consequent movements of the water levels, requires to be investigated. It will be realized that when the hanging lift touches the rest blocks in the tank and the cup of the floating lift is gradually relieved of the load, the level of the water in compartment T will eventually fall by an amount equal to the gas pressure thrown by the landed lift. This fall in the level of the water will relieve the pressure of trapped gas in the dip compartments B and C. The result of this reduction in pressure will therefore cause the levels of the water in compartments A and C to fall, while the water level in compartment B rises. Now if the level of the water in compartment C falls to such an extent that its position is just below the bottom of the cup, blowing of the trapped gas under the cup to the inside of the holder will then occur. The blowing of gas will continue in this manner until the height of the water column in compartments A to B balances the column of water in compartments C to T. Let the positions of the water levels in the various cup and tank compartments for the fourth critical stage be represented by the terms A_4, B_4, C_4, T_4 and H_4. Then the distances between the water levels in these compartments for the third to the fourth critical stage may be expressed by the nomenclature (A_3A_4) (B_3B_4), (C_3C_4), (T_3T_4) and (H_3H_4). If p_h = the fall of the water level T_3 due to the reduction in the gasholder pressure as a lift is landed and f′ = the fall of the water level T_3, so that $(C_3C_4) = (C_1C_3)$, then for the fourth critical stage to exist, one of the following conditions must obtain:

$p_h > f'$, where critical stage (II) occurs in the sequence, or $p_h > F$, where critical stage (II) does not occur in the sequence.

Now the relationship between f′ and (C_3C_4) may be found from the following expressions:

$$f' = (A_3A_4) + (B_3B_4) + (C_3C_4) \quad \text{.....(21)}$$

Now $$(A_3A_4) = \frac{b(B_3B_4)}{a} = \frac{c(C_3C_4)}{a} \quad \text{.....(22)}$$

and $$(B_3B_4) = \frac{c(C_3C_4)}{b} \quad \text{.....(23)}$$

Then $$f' = \frac{c(C_3C_4)}{a} + \frac{c(C_3C_4)}{b} + (C_3C_4) \quad \text{.....(24)}$$

As the value of $(C_3C_4) = (C_1C_3)$ is known, the magnitude of f′ may be ascertained from the above equation.

Then $(T_3T_4) = f'$. The water level H_4 will remain in the same position as H_3, so that $(H_3H_4) = 0$. The levels of the water in the various compartments of the cup and tank are determined from equations (22), (23) and (24). These levels may now be indicated for the fourth critical stage, as shown in Figure 12.

If $p_h \leqq f'$, where critical stage (II) occurs in the sequence, or $p_h \leqq F$, where critical stage (II) does not occur in the sequence, then the trapped gas in the dip will not blow under the cup channel and the fourth critical stage will therefore not obtain. In this case the fifth critical stage will be approached immediately after the third critical stage, as shown diagrammatically in Figure 9.

FIFTH CRITICAL STAGE (V)

As soon as the hanging lift is completely grounded and the gas pressure in the floating holder has fallen by an amount equal to the pressure thrown by the lift, the fifth critical stage is reached. It has already been shown that this critical stage may be approached directly on leaving critical stage (III), or alternatively, after leaving critical stage (IV). If critical stage (V) follows critical stage (IV), then the water level in compartment T will continue to fall until the fifth critical stage is reached. The water level in compartment C will then remain in its position at the bottom of the cup, while some of the trapped gas blows under the cup channel. The water level in compartment B will rise, while that in compartment A will fall.

(To be concluded)

INSTITUTION OF GAS ENGINEERS

A CO-OPERATIVE TRIAL OF THE MAINTAINED-TEMPERATURE REFRACTORINESS-UNDER-LOAD TEST*

By Members of the Specifications Sub-Committee of the Refractory Materials Joint Committee of the Gas Research Board and the British Refractories Research Association

OF recent years the maintained-temperature variant of the refractoriness-under-load test has come increasingly into favour, probably because the conditions of load and temperature can be chosen to correspond more closely to those sustained by the refractories in actual service. For some months the Specifications Sub-Committee of the Refractory Materials Joint Committee of the Gas Research Board and the British Refractories Research Association has been considering whether to recommend the adoption of a Maintained-Temperature Refractoriness-under-Load Test in a revised issue of "Standard Specifications for Refractory Materials for Gas Works."

One of the problems encountered in drafting a suitable experimental procedure was the method to be adopted in measuring the deformation of the test-piece. The following results (Table I) on a number of siliceous materials at a maintained temperature of 1,300°C. illustrate this point.

From a consideration of the type of service to which the materials would be submitted, preference may *a priori* be expressed for a measurement of the alteration in dimensions of the test-piece while at the maintained high temperature. Of the two alternatives (*a*) or (*b*), the latter probably gives a better indication of the deformability of the material, but a difficulty is introduced should the specimen attain its maximum size before the specified temperature is reached and before the thrust column as a whole has attained a steady condition of temperature.

TABLE I.—MAINTAINED-TEMPERATURE REFRACTORINESS-UNDER-LOAD TEST ON SILICEOUS MATERIALS.

Temperature : 1,300°C. maintained for 4 hr.
Load : 28 lb. per sq.in.
Test-piece : 2.5 in. × 1.75 in. × 1.75 in.

Material	Percentage Deformation			
	Measured at 1,300°C.		Measured Cold	
	(*a*)	(*b*)	(*c*)	(*d*)
1	2	3	4	5
2	1.08	1.18	0.63	0.20
	0.90	0.98	0.75	0.44
	0.90	0.95	0.88	0.40
3	0.38	0.69	0.35	0.24
	0.78	0.88	0.40	0.12
	0.68	0.78	0.40	0.16
6	0.98	1.05	0.75	0.16
7	1.95	1.98	1.70	1.04
11	0.60	0.68	0.55	0.04
	0.60	0.75	0.48	0.32
	0.60	0.70	0.33	0.09

(*a*) Based on the pointer readings from the time the test-piece first attained 1,300°C. until the expiration of the 4-hr. period.

(*b*) Based on the pointer readings from the time the test-piece attained its maximum size until the completion of the 4-hr. period.

(*c*) Based on the difference between the original pointer reading before heating was commenced and the final reading when the furnace had again become cold.

(*d*) Based on calliper measurements of the test-piece before and after the test.

Furthermore, this condition is probably not attained until the test-piece has been kept at the prescribed temperature for 10 to 15 min. A disadvantage in method (*a*) is that appreciable contraction of the test-piece may occur before it has attained the requisite temperature. With regard to the measurements on the cold test-pieces, method (*d*), using callipers, is superior to method (*c*), since it is the more direct. Using measurements on the cold test-piece as a basis of reference ignores the effect of constitutional changes in the test material, but in general a specimen which contracts markedly at high temperatures will necessarily display a similar contraction when measured cold.

It was therefore decided that a first trial should be made of the maintained-temperature test, using calliper measurements of the cold test-piece as the method of assessing its stability under load at high temperatures. The following experimental procedure was agreed :

* From Communication No. 2 of the Gas Research Board.

Procedure for the Maintained-Temperature Refractoriness-under-Load Test

"The test-piece is ground to the shape of a rectangular prism, measuring 2.5 in. by 1.75 in. by 1.75 in. The ends must be ground flat and parallel. The height of the test-piece is measured with vernier callipers to 0.001 in. in two directions at right angles. The two positions of the callipers are marked with a refractory stain. The test may be carried out in a gas-fired, oil-fired, or electric resistance furnace, but it is essential that an atmosphere containing free oxygen be maintained throughout the test. The furnace must have a zone of uniform high temperature extending for a short distance above and below the test-piece, and must be capable of accurate temperature control.

"A constant load of 28 lb. per sq. in. is transmitted to the test-piece through a suitable thrust column. The temperature of the test-piece is raised at a uniform rate of 10°C. per min. to the prescribed temperature (1,300°C. in the tests here considered), which is maintained to within ±15°C. for 3 hr. A noble metal thermocouple placed in contact with the centre of one vertical face of the test-piece is used to indicate the temperature up to 1,300°C., upon reaching which it is removed. From 800°C. upwards an optical pyrometer is sighted on the test-piece from all sides so that an even temperature may be assured. Temperature readings are taken every 5 min. After the expiration of 3 hr. at the prescribed temperature the heating is discontinued. When the test-piece is cold, it is removed from the furnace and its height measured with the vernier callipers in the same two positions as previously. The percentage contraction in the two positions is determined and the mean taken."

The First Co-operative Test

Two brands of siliceous brick designated A and B were selected for the test. Five bricks from the same batch of each brand were used and three test-pieces from each brick were roughly ground to shape. Each of the five laboratories participating in the test referred to as C, D, E, F, and G received three roughly-shaped specimens of material A and three of material B. Some samples were taken with their 1.75 in. by 1.75 in. cross-sections perpendicular to the 9 in. by 4½ in. face of the brick and some with their cross-sections parallel to that face.

The results obtained in the different laboratories on applying the test as previously described are given in Table II.

The results show considerable variation for both materials, that for material B ranging from 1.50% to 0%. The fact that in some instances widely different results were obtained in repeat determinations in the same laboratory tends to indicate that the specimens from different bricks of the same brand were not closely similar in their properties. It might also appear that bricks A1, A2, A3, and B1, B2, and B4 were more deformable at one end than the other, one end perhaps being harder fired, but the different results on the same samples taken from these bricks can be attributed just as satisfactorily to slight differences of working in the different laboratories. In this connexion it should be noted that when dealing with samples from the same brick, laboratories C and D always obtained higher results than E and that laboratories D and F always obtained higher results than G.

Some confirmation of the imperfect uniformity of the test material was obtained from the results obtained in a further independent laboratory using a different procedure. In this case specimens in the form of 1-in. cubes were heated to 1,300°C. under a load of 1 lb. per sq. in. and the deformation was obtained from measurements with an Ames dial made on the cold specimens before and after the test. Three results for material A were : (1) an expansion of 1.56% ; (2) 0.0% ; (3) a contraction of 1.1% ; and for material B contractions of : (1) 2.2% ; (2) 1.6% ; (3) 1.86%.

It was hoped that the co-operative tests would throw light on any consistent variation that might occur between samples taken parallel to and at right angles to the 9 in. by 4.5 in. face of the brick, but obviously no conclusions can be drawn on this point. The outstanding feature is the variability of the results

obtained, but the evidence is inconclusive whether the variability is to be atributed to the test materials or to the methods of working in the different laboratories.

TABLE II.—Percentage Deformations of Test-pieces from Materials A and B submitted to a Load of 28 lb. per sq. in. at 1,300°C. for 3 Hr. as Determined in Laboratories C, D, E, F, and G.

Brick	Sample	Position of Sample	Laboratory	Percentage Deformation	
				Material A	Material B
1	2	3	4	5	6
1	(1)	Near 4.5 in. × 3 in. face. Cross-section of test-piece parallel to 9 in. × 4.5 in. face of brick.	C	0.48	1.50
	(2)	Central position. Cross-section of test-piece parallel to 9 in. × 4.5 in. face of brick.	D	0.44	0.78
	(3)	Near other 4.5 in. × 3 in. face. Cross-section parallel to 9 in. × 4.5 in. face of brick	E	0.16	0.08
2	(1)	As for 1 (1)	F	0.43	0.59
	(2)	As for 1 (2)	G	0.08	0.10
	(3)	As for 1 (3)	G	0.04	0.12
3	(1)	Near 4.5 in. × 3 in. face. Cross-piece of test-piece perpendicular to 9 in. × 4.5 in. face.	D	0.36	0.36
	(2)	Central position. Cross-section of test-piece perpendicular to 9 in. × 4.5 in. face of brick	C	0.00	0.30
	(3)	Near other 4.5 in. × 3 in. face. Cross-section perpendicular to 9 in. × 4.5 in. face of brick	G	0.04	0.24
4	(1)	As for 3 (1)	E	0.02	0.00
	(2)	As for 3 (2)	F	0.03	1.01
	(3)	As for 3 (3)	F	0.02	1.06
5	(1)	As for 1 (1)	D	0.36	0.12
	(2)	As for 1 (2)	E	*	0.00
	(3)	As for 3 (3)	C	0.04	0.18

* Test-piece unsatisfactory. The result for a further sample : 0.035.

The Second Co-operative Test

In this test the experimental material was carefully chosen so as to eliminate as far as possible the effect of variability in the samples. It consisted of a large fireclay block manufactured by bonding graded grog with clay and refiring. The grog content was reported as over 90%. Samples roughly ground to shape were selected from the periphery of the block as indicated in Fig. 1 and submitted to the different laboratories.

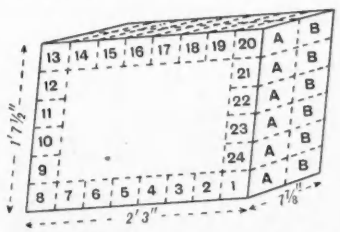

Fig. 1.—*Location of Specimens in the Block of Fireclay Test Material.*

The same details of experimental procedure were circulated to each laboratory. They were identical with those already given but included in addition the use of pyrometric cones as an indication of the heat work performed on the test-specimens. Pyrometric cones 11, 12, 13, and 14, suitably mounted on an aluminous refractory plaque, were placed at the base around each side of the test-piece. One box of 100 cones of each denomination was set apart for the work. At the conclusion of the test the used cones were returned to laboratory G for the collation of the data.

Experimental Results.

The essential details of the reported results are given in Table III.

A further test in an independent laboratory using 1 in. cube specimens subjected to a load of 1 lb. per sq. in. for 3 hr. at 1,300°C. yielded the following results : Specimen 6A, contraction 0.74% ; specimen 15B, contraction 0.72% ; average cone value of heat work, 12¼.

Discussion of Results

A significant feature of the results is that although satisfactory compliance with the condition that the temperature should be maintained at 1,300° ±15°C. for 3 hr. was reported in every instance, nevertheless a variation in " heat work " is indicated by the cones from an average value of 10⅝ to 13¾. The uniformity of temperature around the test-pieces would appear to have been satisfactory. The range covered by the results for the percentage mean deformation is 0.67 to 3.02.

TABLE III.—Percentage Deformations of Test-pieces from a Single Refractory Block, Submitted to a Load of 28 lb. per sq. in. at 1,300°C. for 3 Hr. as Determined in Laboratories C, D, E, F, and G.

Test-Piece	Laboratory	Cones				Average Cone	Reported Average Soaking Temperature, °C.	Mean Deformation per cent.
		N	E	S	W			
1	2	3	4	5	6	7	8	9
10A	C	13	13	12½	13	12⅞	1,304	1.49
11A	G	12½	—	12½	—	12½	—	1.04
12A	E	12½	12	11	—	11⅝	1,294	0.69
13A	D	13½	13	13	13½	13¼	1,300	3.02
14A	G	11½	—	12½	—	12	—	0.96
15A	F	10⅝	10	11	11	10⅝	1,299	1.60
22A	G	12½	—	12½	—	12½	—	1.04
2B	G	11½	—	11½	—	11½	—	1.05
6B	F	12½	12½	12½	12	12⅜	1,300	1.73
7B	D	14	13	14	14	13⅞	1,307	2.67
8B	G	11	—	11½	—	11½	—	0.82
9B	E	12½	12	12	—	12⅛	1,298	0.67
10B	C	14	13½	13	13	13⅜	1,304	1.62
19B	G	12	—	—	—	12	—	0.87

This is a considerable range for the type of test material used. It would appear that at temperatures from 1,300°C. upwards appreciable changes can occur within the specimens and that the kiln firing had not been equivalent in heat work to 3 hr. at 1,300°C. Microscopic examination of the 1-in. cube specimens after testing indicated that considerable constitutional changes had occurred. Table IV makes this clear.

The clay refractive index 1.555 to 1.563 is regarded as a reaction product of quartz and clay, and it is significant that after heat

TABLE IV.—Percentage Results of Microscopic Examination of Test Material.

Material	Before Test	After Test
1	2	3
Quartz	3	< 1
Clay, refractive index 1.555 to 1.563	7	20
Clay, refractive index 1.563	65	70
Clay, refractive index 1.569	25	10

treatment at 1,300°C. the quartz had almost completely disappeared, while the percentage of this fraction had increased from 7 to 20%. There was also a marked decrease in the quantity of the clay of highest refractive index.

It is noteworthy, however, that there is a relation between the degree of " heat work " as indicated by the cones and the reported deformation. This is made apparent by plotting the percentage deformation against the cone indications (see fig. 2).

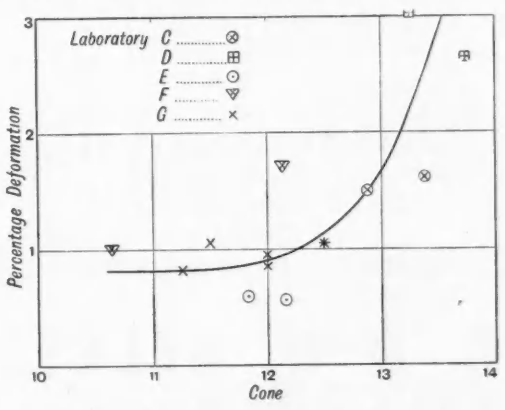

Fig. 2.—*Relation Between Heat Work Measured in Cones and the Deformation of Specimens in Maintained Temperature Refractoriness-under-Load, Tests carried out in Different Laboratories.*

This general relationship is also substantiated by individual results. For instance, in the case of 6B the heat treatment on each side of the test-piece was very similar and the contractions no each of the four sides as measured by a micrometer gauge

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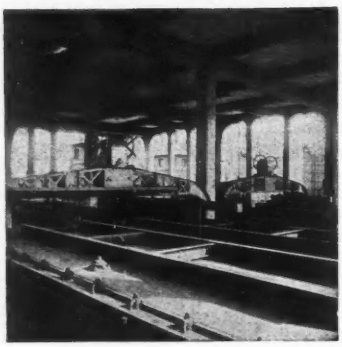

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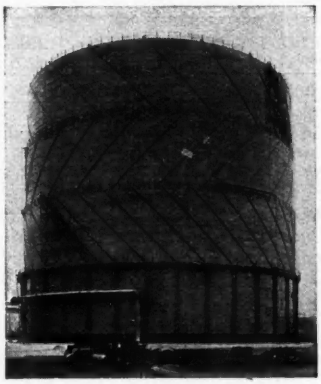

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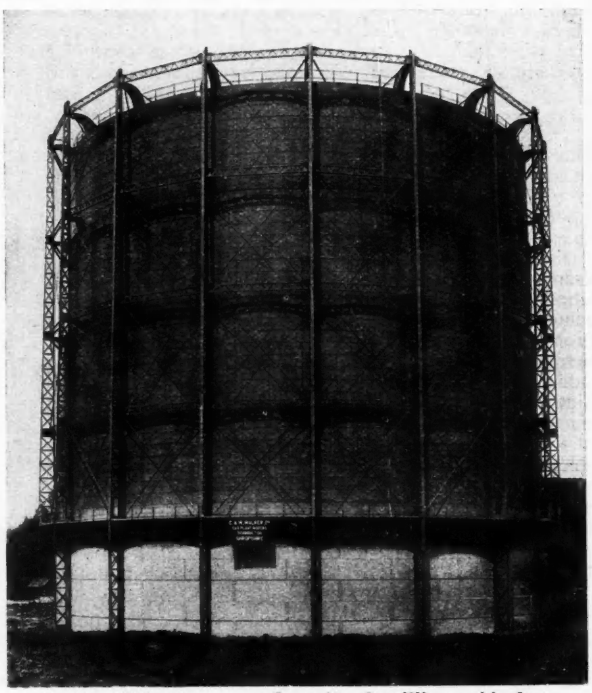

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were also close. In the corresponding test on 15A the heat treatment was not so uniform and the variation in contraction was also greater. The individual results are given in Table V, and show the correlation between heat work as measured by the pyrometric cones and the contraction of the test-piece.

TABLE V.—Relation Between Heat Work and Deformation on the Different Sides of Test-Pieces in the Maintained-Temperature Refractoriness-under-Load Test.

Side	Test 15A		Test 6B	
	Cone	Contraction in $\frac{1}{1000}$ in. at each corner	Cone	Contraction in $\frac{1}{1000}$ in. at each corner
1	2	3	4	5
N	10½	31–21	12½	44–44
E	10	21–18	12½	44–45
S	11	18–29	12½	45–41
W	11	29–31	12	41–44

It is also apparent from the plot of the results that the duplicate determinations of each laboratory were in better accord with each other than with the measurements made by different workers, a fact which tends to confirm the essential uniformity of the material. Indeed, laboratory G tested six samples from various parts of the periphery of the block and the results for the percentage deformation lay within the limits 0.82 to 1.05. In view of the satisfactory correlation between cone values and deformation of the test-pieces it would appear that differences between the different pyrometers in use would provide a reasonable explanation of the variation in the reported results. Thus D's pyrometer may have read relatively slightly low, while E and G may have used pyrometers which read relatively somewhat high. In spite of an overall variation of more than three cones it is probable that temperature differences of only a small number of degrees Centigrade are in question. A difference in average temperature of 13°C. between laboratories E and D is indeed admitted for the results on test 12A (average temperature 1,294°C.) and 7B (average temperature 1,307°C.). It is apparently the cumulative effect of the 3-hr. duration of the test which emphasizes the divergence. A comparison of the actual pyrometer readings in tests 15A and 6B, which were made at the same laboratory, reveals little divergence. The significant differences in the temperature control during the two tests are summarized in Table VI. In the case of laboratories D and E, however, a wider divergence in the reported average temperatures resulted in less divergence in the final condition of the cones.

TABLE VI.—Comparison of Pyrometer Readings and Cone Values obtained in Two Maintained-Temperature Refractoriness-under-Load Tests.

Test	Average Temperature, °C.	Maximum Temperature, °C.	Period above 1,300°C., min.	Average Cone
1	2	3	4	5
15A	1,299	1,315	72.5	10⅜
6B	1,300	1,315	101.5	12⅜

Conclusions

From the results presented it seems clear that the Maintained-Temperature Refractoriness-under-Load Test is unsuitable in its present form as a standard method for general use. The main difficulty would appear to be that deformation characteristics of firebrick and siliceous materials alter rapidly at temperatures in the neighbourhood of 1,300°C. The measurement of deformation under load at such temperatures thus probably entails, among other essentials, particularly accurate temperature control and accurately calibrated temperature measuring instruments. Unfortunately 1,300°C. is perhaps the lowest temperature which would command any confidence in a refractoriness-under-load test for judging the suitability of material for use in many types of high-temperature installation. However, it is apparent that before progress can be made, reliable data are required on the effect of temperature on the pyroplastic properties and deformation characteristics of different types of refractory. A scheme of research in this field is being undertaken.

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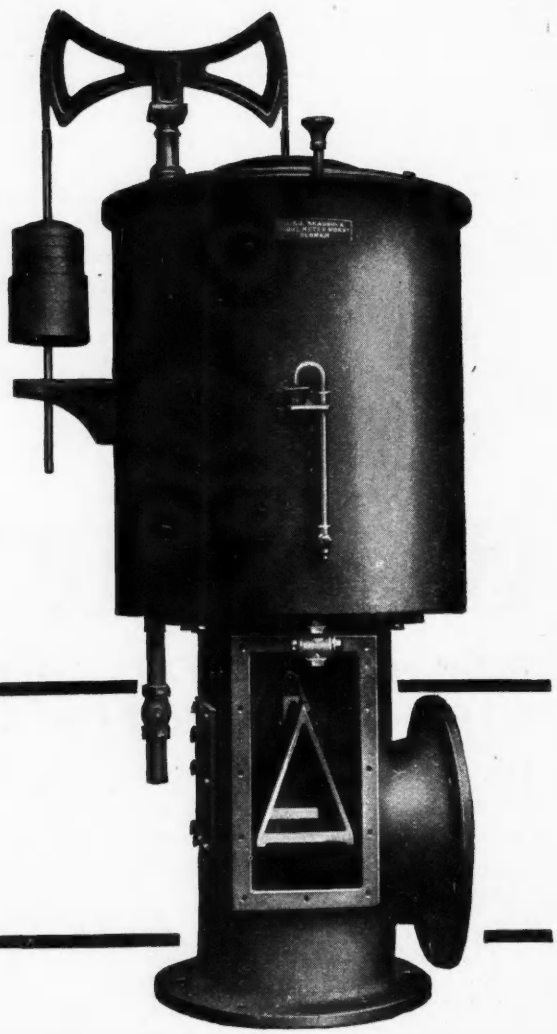

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Gas Products Prices

The London Market

Jan. 13.

There is no change to report in the prices of Tar Products in the London Market. Values remain to-day as under : Pitch nominal ; creosote 4¾d. to 5d. per gallon ; refined tar 3¾d. to 4d. ; pure toluene under the Ministry of Supply Toluene No. 2 Order 2s. 5d. ; pure benzole is 1s. 10d. ; 95/160 solvent naphtha 2s. 3d., and 90/160 pyridine 15s., all per gallon naked ; refined crystal naphthalene £23 per ton in bags ; all *ex* Makers' Works.

The Provinces

Jan. 13.

The average prices of gas-works products during the week were : Pitch and Crude Tar,* Toluole, naked, North, 1s. 10d. (controlled by the Control of Toluene No. 2 Order, July 5, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North 9½d. to 10d. Solvent naphtha, naked, North, 1s. 9d. to 1s. 10d. Heavy naphtha, North, 1s. 5d. to 1s. 6d. Creosote, *ex* works, in bulk, North liquid and salty, 4¼d. to 4¾d. ; Scotland, 4¼d. to 4¾d. ; low gravity, 4¼d. to 4¾d. Fuel Grade 4d. to 4¼d. Carbolic acid, 60's, 3s. 9d. to 3s. 10½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil (min. gr. 1,080), 5¼d. to 5½d. ; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d. ; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note in our issue of Sept. 4, 1940, p. 404.

Tar Products in Scotland

GLASGOW, Jan. 11.

If anything there has been an increase in the volume of business being placed both for prompt and forward delivery. Prices are well held.

Refined tar is quietly steady in the home market at 4½d. to 4¾d. per gallon, while for export price is unchanged at 3½d. to 3¾d. per gallon, both f.o.r. naked.

Creosote oil continues quite active at the following prices : Specification oil, 5d. to 5¼d. per gallon ; low gravity, 6d. to 6½d. per gallon ; neutral oil, 5¾d. to 6d. per gallon ; all *ex* Works in bulk.

Cresylic acid remains rather dull with makers' prices showing no alteration as follows : Pale, 99/100%, 2s. to 2s. 2d. per gallon ; Pale, 97/99%, 1s. 9d. to 1s. 10d. per gallon ; Dark, 97/99%, 1s. 6d. to 1s. 7d. per gallon ; all *ex* Works in buyers' packages.

Crude naphtha is only available in small quantities with value called 6½d. to 7½d. per gallon *ex* Works in bulk, according to quality.

Solvent naphtha is in good call at 1s. 8½d. to 1s. 9d. per gallon for 90/160 grade and 1s. 4½d. to 1s. 5½d. per gallon for 90/190 heavy naphtha.

Pyridine is easy at about 17s. to 18s. per gallon for 90/160 grade and 19s. to 20s. per gallon for 90/140 grade.

Calendars, Diaries, &c., Received.

Seasonable gifts in the form of Calendars, Diaries, &c., have been received from the undermentioned friends, whose good wishes are cordially reciprocated :

Newton Chambers & Co., Ltd., Sheffield.
Harris & Pears, Ltd., Stourbridge.
Clayton, Son & Co., Leeds.
R. & A. Main, Ltd., London and Falkirk.
Underpressure Engineering Co., Ltd., Mansfield.

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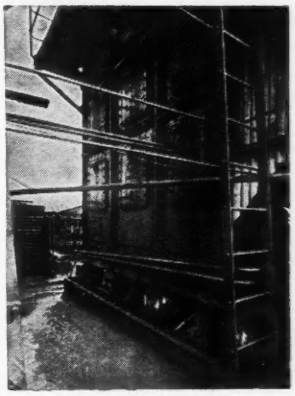
PERMAC JOINTS



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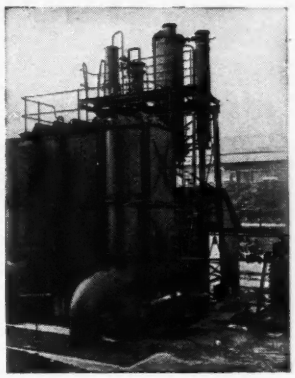

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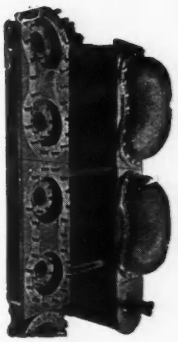

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GAS STOCKS AND SHARES

The past week closed with quiet conditions prevailing in most sections of the Stock Exchange. A small amount of week-end profit taking was in evidence which caused some minor irregularity here and there, but on the whole the undertone was firm. British Funds received some investment demand and quotations were fractionally higher than at the commencement of the year—2½% Consols being ¾ up at 77½. Dominion and Colonial stocks were also firm. Home rails displayed strength, with Southern preferred a feature. A few bright spots were noticeable in the industrial section, especially I.C.I. and London Brick, but English bank shares weakened, although all dividends so far announced are at the same rates as a year ago.

The recent advance in Kaffir shares continued, and more interest was taken in tea shares, but oils were less active.

There was more support than of late for gas stocks and shares, especially among Gas Light units, Imperial Continental, and South Metropolitan stocks. The units closed 3d. higher at 14s. 9d., and support for Imperial Continental took the price up 5 points to 46½, the stock changing hands as high as 47, while South Metropolitan 6% preference rose 2 points to 104½. Apart from *ex* interest markings no changes occurred in either the Supplementary List or on the Provincial Exchanges.

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Jan. 9.	Rise or Fall on week.
1,767,439	Sept. 16	7	7	Alliance & Dublin Ord. ...	112—122	...
374,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	90—95	...
957,608	Nov. 4	5	5	Asscd. Gas & Water U'd'ts Ord.	12/—14/–	.
300,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	15/—17/–	—/6
335,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/—14/–	...
361,370	Aug. 12	7	7	Barnet Ord. 7 p.c.	98—103	...
300,000	Oct. 14	1/9⅜	1/4⅜	Bombay, Ltd.	19/6—21/6	..
690,407	Aug. 19	7	7	Bournemouth 7 p.c. max. ...	100—110	...
362,025	Dec. 16	4	4	Do. 4 p.c. Deb. ...	79—84	...
659,955	Aug. 19	6½	4⅜	Brighton, &c., 5 p.c. Con. ...	65—75	...
855,000	Sept 30	8	6	Brit. Gas Light Ord.	75—85	...
545,000	Dec. 16	5½	5½	Do. 5½ p.c. 'B' Cum. Pref	105—115	—½
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	73—78	...
10,000	Nov. 6, '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	¼—¾	...
626,860	July 15	5⅞	6	Cardiff Con. Ord.	89—94	...
24,500	Sept. 23	7	7	Colombo Ord. 7 p.c. Pref. ...	19/—21/–	...
764,169	Oct. 7	/11.48	-/11.48	Colonial Gas Assn. Ltd. Ord. ..	14/—16/–	...
400,000	,,	1/3.30	1/3.30	Do. 8 p.c. Pref. ...	19/—21/–	...
1,748,935	July 22	2	3	Commercial Ord.	37—42	...
620,000	Dec. 9	3	3	Do. 3 p.c. Deb.	57—62	...
286,344	Aug. 19	5	5	Do. 5 p.c. Deb.	87—92	...
807,560	Aug. 12	7	6	Croydon sliding scale	83—88	...
644,590	,,	5	5	Do. max. div.	79—84	...
620,385	Dec. 30	5	5	Do. 5 p.c. Perp. Deb. ...	90—95	...
179,500	Aug. 19	5⅜	5	East Surrey 'B,' 5 p.c.	60—70	...
176,461	Dec. 16	5	5	Do. 5 p.c. Deb. (Irred.)...	87—92	...
250,000	Nov. 11	4	6	Gas Consolidation Ord. 'B' ...	13/6—14/6	...
250,000	Nov. 11	4	4	Do. 4 p.c. Red. Cum. Pref.	15/—17/–	...
19,123,018	July 29	3¾	4½	Gas Light & Coke Ord. ...	14/3—15/3a	+/3
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	50—55	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	72—77	...
2,993,000	July 8	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	82—87	...
8,602,497	Dec. 2	3	3	Do. 3 p.c. Con. Deb. ...	69—74	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	98—103	...
700,000	Sept. 9	3½	3½	Do. 3½ Red. Deb.	80—85	...
3,600,000	May 13	4	8	Imperial Continental Cap. ...	44—49	+5
43,820	July 29	3½	3½	Do. 3½ p.c. Red. Deb. ...	61—66	—2
231,978	Aug. 19	5	5	M.S. Utility 'C' Cons.	68—73	...
918,657	,,	4	4	4 p.c. Cons. Pref.	72—77	...
675,000	Nov. 11	†4	†4	Montevideo, Ltd.	52—57	...
300,000	Nov. 18	7	9	Oriental, Ltd.	105—115	+5
368,537	Dec. 9	8	6½	Plymouth & Stonehouse 5 p.c.	88—98	...
621,667	Aug. 19	8½	7½	Portsmouth & Gosport Cons.	90—95	...
648,999	Sept. 16	1/1	1/1½	Severn Val. Gas Cor. Ld. Ord.	13/—15/–	...
597,972	,,	-/10⅝	-/10⅝	Do. 4½ p.c. Cum. Pref. ...	15/6—17/6	...
2,528,714	Sept. 2	1/–	-/7½	South East'n Gas Cn. Ld. Ord.	9/—11/–	...
1,000,000	,,	-/10⅝	-/10⅝	Do. 4½ p.c. Red. Cum. Pref.	14/—16/–	...
1,068,869	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/6—14/6	...
4,709,895	Aug. 5	4	4	South Met. Ord.	53—58	...
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	102—107	+2
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	69—74	...
1,895,445	Dec. 30	3	3	Do. 3 p.c. Perp. Deb. ...	60—65*	...
1,000,000	July 15	5	5	Do. 5 p.c. Red. Deb. ...	97—102	...
1,543,795	July 22	3	4	South Suburban Ord. 5 p.c. ...	62—67	...
512,825	July 8	5	5	Do. 5 p.c. Perp. Pref. ...	85—90	...
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	63—68	...
250,000	,,	3⅜	3⅜	Do. 3⅜ p.c. Red. Pref. ...	80—85	...
888,587	Dec. 16	5	5	Do. 5 p.c. Perp. Deb. ...	90—95	...
750,541	Aug. 9	5½	5	Southampton Ord.	57—62	...
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	91—96	...
1,076,495	Aug. 5	5	5	Tottenham & District Ord. ...	62—67	...
338,555	,,	5	5	Do. 5 p.c. Pref.	78—83	...
453,380	Dec. 9	4	4	Do. 4 p.c. Perp. Deb. ...	76—81	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	13/—15/–	...
1,085,952	Nov. 25	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	13/6—15/6	..
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	13/—15/–	...
745,263	Dec. 16	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	12/—14/–	...
1,200,000	Sept. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	82—87	...
380,608	Aug. 5	7	6½	Uxbridge, &c., 5 p.c.	80—90	...
1,371,138	July 8	3½	4	Wandsworth Consolidated ...	66—71	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	63—68	...
1,343,964	Dec. 16	5	5	Do. 5 p.c. Deb.	88—93	...
383,745	,,	4	4	Do. 4 p.c. Deb.	75—80	...
558,342	July 15	6	5	Watford & St. Albans Ord. ...	85—90	...
300,000	Dec. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	84—89	...

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Jan. 9.	Rise or Fall on week
351,685	Dec. 16	5	5	Brighton, &c., 5 p.c. Perp. Deb.	88—93	...
28,700	,, 17	5½	5½	Do. 5½ p.c. Red. Deb. 1942...	95—100	...
415,250	,, 23	4	4	Bristol Gas Co., 4 p.c. New Deb.	83—88	...
140,205	July 29	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	100—110	...
295,932	Aug. 19	5	5	Cheltenham, 5 p.c. Cons. Ord....	88—93	...
42,500	Dec. 16	4	4	Do. 4 p.c. Perp. Deb....	75—80	...
150,000	Aug. 12	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	65—75	...
130,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	75—80*	...
146,700	Aug. 19	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	80—90	...
53,220	,, 19	6	6	Do. 6 p.c. Cum. Pref. ...	90—100	...
117,425	Feb. 5	8	8	East Wight, 5 p.c. Cons. Ord. ...	100—110	...
...	Aug. 19	6	4	Eastbourne, 'B' 3½ p.c.... ..	65—75	...
239,135	Nov. 11	5	5	Gas Consolidation 'A' Ord. (£1)	13/—15/–	...
156,600	Aug. 19	5	5	Hampton C't, 5 p.c. Cons. Ord.	68—73	...
18,000	Dec. 2	7	7	Malta & Med'n., 7 p.c. 1st Pref.	55—65	...
10,845	,, 2	7½	7½	Do. 7½ p.c. 2nd Pref.	55—65	...
50,000	Aug. 19	£5 19 6	£5 4 6	Mid. South. Util., 'A' Cons. 5 p.c.	60—70	
65,000	Aug. 12	5	5	North Middlesex, 5 p.c. Pref....	87—92	...
70,000	Sept. 9	5	5	Plymouth & Stone., 5 p.c. Deb.	87—92	...
76,501	Dec. 30	4	4	Reading, 4 p.c. Perp. Deb. ...	75—80*	...
74,777	Sept. 30	4	4	Romford, 4 p.c. Debs. (Reg.) ...	77—82	...
21,000	Dec. 16	5	5	Slough, 5 p.c. Perp. Deb. ...	87—92*	...
211,740	,, 30	5	5	Southampton, 5 p.c. Red. Deb.	90—95*	...
363,575	Dec. 30	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	94—99*	— 1
202,019	Oct. 14	6⅝	6⅝	Tunbridge Wells, 4 p.c. Scale ...	70—80	...
135,257	June 10	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	88—93	...

PROVINCIAL EXCHANGES

					Quotations Jan. 3.	
47,756	July 26	6	5	Bath Cons.	94—98	...
122,577	July 22	7	6	Blyth 5 p.c. Ord.	100—105	..
1,667,250	July 15	5	5	Bristol, 5 p.c. max.	90—93	...
120,420	Dec. 16	4	4	Do. 1st 4 p.c. Deb.	92½—94½*	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	91—94*	...
328,790	,,	5	5	Do. 5 p.c. Deb.	107—110*	...
157,150	Aug. 5	6½	5	Chester 5 p.c. Ord.	98—101	...
92,500	Dec. 16	4	4	Do. 4 p.c. Pref.	79—84*	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	79—84*	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	93—97*	...
542,270	Aug. 12	9	6	Derby Cons.	100—105	...
55,000	Dec. 16	4	4	Do. 4 p.c. Deb.	77—82	...
10,000	Aug. 19	10	10	Great Grimsby 'A' Ord. ...	165—175	...
6,500	,,	10	10	Do. 'B' Ord. ...	165—175	...
79,000	,,	10	10	Do. 'C' Ord. ...	155—165	...
732,000	Aug. 26	4	4	Hartlepool G. & W. Cn. & New	61—63	...
2,167,410	Aug. 19	6	6	Liverpool 5 p.c. Ord.	97—100	...
245,500	Dec. 16	5	5	Do. 5 p.c. Red. Pref. ...	97½—100½*	...
306,083	July 15	4	4	Do. 4 p.c. Deb.	99—101	...
20,000	Dec. 23	5	5	Long Eaton 5 p.c. Pref. ...	9—11*	...
80,000	,,	5	5	Do. 5 p.c. Deb.	92—97*	...
2,430,267	July 29	5⅞	5	Newcastle and Gateshead Con.	16/3—17/3a	...
682,856	,,	4	4	Do. 4 p.c. Pref.	75—77	...
776,706	Dec. 23	3½	3½	Do. 3½ p.c. Deb.	80—85*	...
277,285	Oct. 21	5	5	Do. 5 p.c. Deb. '43 ...	97—102	...
274,000	July 26	5	5	Newport (Mon.) Ord.	89—93	...
13,200	Sept. 16	8½	7	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	6	5	Do. 7 p.c. 'B'	9½—10½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½	...
106,280	Aug. 5	8	10	Preston 'A' 10 p.c.	157—167	...
188,219	,,	7	7	Do. 'B' 7 p.c.	113—123	...
1,806,339	Aug. 26	6½	6½	Sheffield Cons.	118—120	...
95,000	July 8	4	4	Do. 4 p.c. Deb.	97— 99	...
332,351	Feb. 5	6	6	Sunderland 6 p.c. max. ...	107—112	..
140,778	Aug. 12	5	5	Weston-super-Mare Cons. ...	80—85	...
64,338	Dec. 30	4	4	Do. 4 p.c. Deb.	75—85*	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	135—143	—2

a.—The quotation is per £1 of Stock. * Ex div. † Price free of income-tax.

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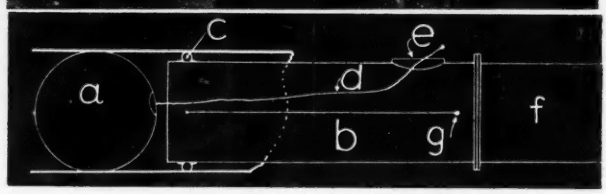

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